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CONTENTS

	Page
Man-power in Great Britain : I. Scientific Management and Industrial Relations	421
The Clash of Cultures. By Prof. H. J. Fleure, F.R.S.	424
Virus Diseases in Practice. By Dr. John Grainger	425
Ectoparasitic Insects. By Dr. J. E. Webb	425
Protein Structure in the Light of Analytical Chemistry. By Dr. D. Jordan Lloyd	426
Endocrine Correlation in the Embryonal Development of the Vertebrates. By Prof. A. N. Studitskii	427
Nutritional Value of Beer. By Dr. F. W. Norris	430
Obituaries :	
Dr. F. W. Lanchester, F.R.S. By Prof. F. T. Hill	432
Mr. Alfred Lucas, O.B.E. By Dr. W. L. Balls, C.B.E., F.R.S., the late R. Engelbach, D. S. Gracie, Dr. H. E. Hurst and L. F. McCallum	433
News and Views	434
Letters to the Editors :	
Constitution of Strychnine and the Biogenetic Relationship of Strychnine and Quinine.—Dr. H. T. Openshaw and Sir Robert Robinson, F.R.S.	438
Isolation of Pregnane-3(α)-ol-20-one from the Hydrolysis Products of 'Sodium Pregnanediol Glucuronidate'.—Prof. G. F. Marrian, F.R.S., and Nancy Gough	438
Reactions of Organic Halides in Solution.—Alwyn G. Evans	438
An Isomeride of Abietic Acid.—Dr. J. H. Christie	439
Quinoxaline and its Monohydrate.—Dr. B. C. Platt	439
Antimalarial Action of Cinnoline Derivatives.—Dr. J. C. E. Simpson and K. Schofield	439
Antimalarial Activity and Toxicity of a Metabolic Derivative of Quinine.—Dr. F. E. Kelsey, F. K. Oldham, W. Cantrell and Dr. E. M. K. Geiling	440
Synthetic Liquid Penicillin Medium with Glycerine as the Sole Source of Carbon Atom.—Dr. S. L. Mukherjee and B. C. Sarkhel	440
Toadstools and Mushrooms as a Source of Antibacterial Substances Active Against *Mycobacterium phlei* and *Bact. typhosum*.—Nancy Atkinson	441
Inhibition of *Mycobacterium tuberculosis* by Garlic Extract.—R. Raghunandana Rao, S. Srinivasa Rao, S. Natarajan and P. R. Venkataraman	441
Bronchial Asthma Caused by the Trickling Sewage Filter Fly (*Psychoda*) : Inhalant Insect Allergy.—Dr. David Ordman	441
Alloxan Diabetes in a Ruminant.—I. G. Jarrett	441
Aphosphorosis in Cattle in Offaly.—Prof. E. J. Sheehy	442
Molybdenum and Copper Metabolism of Farm Animals.—James Stewart, V. C. Farmer and R. L. Mitchell	442
Mechanism of the Proteolytic Activity of Malignant Tissue Cells.—Dr. Albert Fischer	442
Relation of Intracellular Potassium to the Refractory Period of the Frog's Heart.—Prof. J. F. Donegan	442
Physiological Activity of a Single Follicle Occurring in an Aberrant Baboon Ovary.—Dr. A. Culiner	443
Radioactive Tracers in the Study of Friction and Lubrication.—J. N. Gregory	443
Interferometers and the Group Index.—A. C. Candler	444
Stark Effect of Spectrum Lines with Predominating Shifts in Final Levels.—Dr. Lennart Minnhagen	444
Role of Line-Width in the Measurement of the Doppler Displacements in Positive Rays.—Dr. C. Dakshinamurti	445
An Improved Type of Schmidt Camera.—Dorothy G. Hawkins and Dr. E. H. Linfoot	445
Anti-Reflexion Films Evaporated on Glass.—J. Bannon	446
Current Density at the Cathode Spot of the Mercury Arc.—K. D. Froome	446
A Definition of Plasticity.—Dr. R. C. L. Bosworth	447
Need for the Development of Tropical Ecological Stations.—A. P. D. Jones and R. W. J. Keay	447
Literature for the Hong Kong Fisheries Research Station.—G. A. C. Herklots	447
Research Items	448
Clouds : Their Characteristics and Formation	450
Ecology of the Eelworm Cyst. By Dr. C. Ellenby	451
Chemical Nature of Salts from Bones and Teeth and of Tricalcium Phosphate Precipitates. By Dr. H. Brasseur, Dr. M. J. Dallemagne and Dr. J. Melon	453
British Empire Cancer Campaign : Report for 1945. By Dr. E. Boyland	453
International Astronomical Union. By F. J. M. S.	454
Antibacterial Substances Produced by Bacteria and Fungi. By Dr. G. Lapage	455
Viscosity of Liquids and Colloidal Solutions. By Dr. G. W. Scott Blair	455

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MAN-POWER IN GREAT BRITAIN

I. SCIENTIFIC MANAGEMENT AND INDUSTRIAL RELATIONS

MUCH was said during the recent debate in the House of Commons on economic affairs and man-power as to the importance of efficient management in order that we may achieve the maximum increase in production in Britain. It may be true that in some sections of industry there is room for a more progressive attitude towards new plant and machinery, towards research, and towards special training for management ; but even industries which are outstanding in their encouragement of research have provided no exception to the general falling off in output per man-hour. Neither the adoption of more scientific methods of production, nor a large expansion of scientific and industrial research, will of itself raise the rate of production to the high level necessitated by the present state of affairs. Even to secure the full advantage of mechanization involves not merely good management, but also the understanding and support of the operatives.

Indeed, the debate on February 26 and 27 emphasized that Britain is faced with an acute shortage of man-power, and that the attainment of even the pre-war standard of living depends not merely on efficient management making the most economical use of the men and women available, but still more on the energy with which those men and women go to work. As Mr. Attlee said : "If to-day we want houses, clothes, coal, food, the necessities and amenities of life, we have to realize that we cannot depend on other people doing their best to provide for us unless we are ourselves rendering the best service we can". Fundamentally, the problem of increased productivity is one of improved relations between labour and management, better training of the operatives and adequate incentives. Better organisation and layout of factories, more modern buildings and conditions of work, up-to-date methods and machinery, and efficient research and development, are all important ; but good personnel management and those other factors that create the conditions in which the men and women of Britain can give of their best are the most vital at this time.

Industrial relations is a matter involving at least two parties, and such relations can never be satisfactorily established if either party persistently abuses the other. On that ground alone, it is worth noting that the debate showed a welcome freedom from a recent tendency for politicians to abuse business men and industrialists indiscriminately, and the President of the Board of Trade in particular repudiated the suggestion that the industries of Great Britain are generally inefficient. The debate should in fact do something to provide a better basis and understanding for industrial relations, and to stimulate thought about a reliable criterion of industrial efficiency or productivity. In addition to the points made during the debate, there are others which are well brought out in Prof. H. S. Kirkaldy's inaugural lecture at Cambridge last October on "Industrial

Relations in Conditions of Full Employment", which has recently been published[1]. Prof. Kirkaldy, who has succeeded Prof. J. H. Hilton in the Montague Burton chair of industrial relations at Cambridge, referred to the secret of Prof. Hilton's success in handling problems which demonstrated his understanding of the working people; but he did so to emphasize the contrast between the industrial circumstances in which Prof. Hilton delivered his inaugural lecture fourteen years earlier and those of to-day. The fundamental difference was the condition of full employment which had been achieved in time of war. Full employment accompanied by a rising standard of living, however, can be achieved only in time of peace, and presupposes not merely peace between nations but also peace within industry. In the past, industrial relations have been in essence a trial of strength between opposing forces, but Prof. Kirkaldy suggests that the establishment of bodies such as the Catering Wages Boards and the enactment of the Wages Councils Act make it evident that in future wages will in general be regulated either by collective bargaining or by decision of statutory boards. Sectional alliances of employers and employed in individual industries, if they emerge, must not be allowed to develop into wars of exploitation against other industries and the community. The achievement of a higher standard of living for those engaged in all industries involves the avoidance of both internecine strife and wars of exploitation.

Prof. Kirkaldy's lecture is full of warnings on truths that are apt to be disregarded because inconvenient or uncomfortable. For example, postulating that full employment is not to be attained by the sacrifice of the essential liberties of the worker or of the citizen, he reminds the planner that the ultimate judge of such essential liberties is man himself. Again, while social security is an important element in the concept of a rising standard of living, it is at the same time an obstacle in the way of securing it. A rising standard of living assumes increasing production, and increasing production depends largely on increased incentive to produce. Concern with the problem of distributing the national income should not be allowed to obscure the even more vital problem of increasing the national income.

Prof. Kirkaldy's plea as to the urgency of the task which lies to the hand of employers, workers and the State in ensuring that the methods and machinery of industrial relations are perfected, that no needless sources of friction impede their operation, and that the magnitude of the responsibilities of all parties to industrial negotiations is fully realized, might well have been more clearly reflected in the House of Commons debate. In developing his theme further, however, Prof. Kirkaldy examines first the question of wages; he argues that there are limits to the extent that the individual employer or even the employers' association in a single industry should be regarded as trustee for the community, and holds that if there is to be trusteeship, it must be joint trusteeship and on a wider basis than that of the individual industry. The urgent problem of industrial relations in the sphere of wages in conditions of full employment is to relieve the immediate parties of some measure of responsibility in regard to claims which raise important issues of national finance.

Prof. Kirkaldy is arguing here for exactly that national wages policy which, as was emphasized in the recent debate, the Government shows no sign of possessing. As was well pointed out by Mr. Bower, so long as there is no attempt to evolve some kind of national wages policy, re-allocation of the restricted resources of man-power in Britain on the most satisfactory economic basis is impossible. The Government has rightly rejected any dictation of wage-rates to the employers' associations and trade unions as a political impossibility; but it is an abdication of responsibility to leave the machinery of collective bargaining without any guidance about what is in the national interest and with no lead on the proper attitude to adopt towards proposals for shorter hours, guaranteed weeks, holidays with pay, and the like. We are not faced with a choice between chaos and compulsion as the Government attitude implies; and just as the habit of abusing all business men and industrialists is detrimental to co-operation, so the failure to plan this fundamental factor of production can be fatal to the organisation of the production campaign on which the health and strength of the nation literally depend.

On this question Prof. Kirkaldy has much to say that is pertinent. Any attempt to evolve a national wages policy, if it is to have hope of success, must take the form of guidance rather than compulsion. He suggests that the policy itself should if possible be laid down in agreement between the central national organisations of the employers and workers, the British Employers' Confederation and the Trades Union Congress. If that is not possible, it should be worked out by independent persons of established reputation in finance, economics and industry who have the confidence of employers and workers. But without a conscious wage policy we cannot hope to effect the revision and simplification of the wage structure, extend the use of systems of payment by results required in many industries, or introduce greater uniformity of practice between different industries with regard to overtime rates; all these are essential for handling industrial relations successfully in conditions of full employment and for securing the increased production necessary for a rising standard of living if not for national existence.

These questions are one facet of the general problem of incentives on which much stress was laid in the debate, and their importance has been sufficiently emphasized by recent strikes in different branches of industry. Prof. Kirkaldy touches too on the question of taxation, and the psychological effect of the deduction of income tax at the full rate from overtime earnings was a point made very strongly in the House of Commons in favour of some concession. The need for fundamental thinking on this issue and for reform of the present system, which applies the highest rate of taxation to income attributable to the hours additional to normal working time, is implicit in Prof. Kirkaldy's argument.

Recent strikes and trade disputes also underline his observations on a second type of disagreement

resulting in open industrial conflict—those questions which he describes as union, inter-union and demarcation. Here, like Sir William Beveridge and others, he points to the necessity of a new outlook by the trade unions in conditions of full employment. As Prof. Laski has pointed out, their negative and protective or restrictive functions must come to be replaced by something more positive and constructive. Much more attention, too, must clearly be given to the inter-union type of dispute, while the third type of dispute, that arising out of disciplinary questions, equally demands more careful consideration than such disputes have yet received. The workers must recognize that discipline is a necessity of industry, and ,equally management must recognize that affirmation of the foreman or manager is not the sole test of the reasonableness of an order. Orders must be capable of being called in question at the proper time and place; but the proper time and place are not the middle of the industrial process and on the workshop floor.

Prof. Kirkaldy in this lecture states the problems fairly and emphasizes the need for a contribution from both sides; but it is as a challenge to thought that his lecture deserves most attention. He sees the positive contribution which the technician and man of science can make to the improvement of production and industrial relations; and he sees too the dependence of output not merely on technical advance but also on human relations. An atmosphere of hostility between management and men can play havoc with production, and mere foolish lack of tact can poison works atmosphere, just as human understanding can purify it. That has to be remembered in dealing with the establishment of new machinery for consultation and co-operation, such as the joint production committees; and though we may be only at the beginnings of the development of an effective democratic system in industry, that system can only function in an atmosphere of confidence and goodwill.

Prof. Kirkaldy points out what is often forgotten, namely, that the success of such machinery does not depend only on the willingness of employers to operate it, to place their problems before it, and to face and answer criticism of their policy and methods. Success does not depend only on the co-operation of individual workers who sit on committees. It depends also and ultimately on the fundamental objectives of the trade union movement.

Prof. Kirkaldy does not flinch from showing the real challenge which the present situation presents; and in stressing the danger of confusing industrial and political action there is a very clearly implied rebuke to some Government spokesmen for utterances calculated to retard if not to inhibit the increased production for which the Prime Minister has called. Prof. Kirkaldy, however, hopes that the trade union movement as a whole and without reservation will devote its energies in the industrial sphere to increasing the efficiency of industry and improving the standard of life of those engaged in it, and that it will use political means, and political means only, for bringing about any changes in the structure of industry which it regards as necessary for the ultimate well-being of the community. Industrial relations in any industry are not the sphere in which major matters of national policy such as the ownership and control of industry and national policy should be fought out and decided. Prof. Kirkaldy calls for investigation, and he pleads also for more publicity in the affairs and methods of employers' associations and trade unions. There is no finality in industrial relations. Continual study is necessary, and also regular and accurate information. Much of the work of the Oxford Institute of Statistics falls into this class. For example, the first of its new monographs, "Small and Big Business"[2], is a reasoned study of the economic problems of the size of firms, which should help to put policy on a reasoned basis and eliminate prejudiced action. It is true that this particular monograph may require to be translated into terms more generally understandable by the average man; but even if the final two sections analysing the factors which make for the continued existence of small firms and on technical progress and the size of the firm were more widely apprehended, much heat and prejudice would be taken out of current debate.

The increased production to which the Prime Minister has summoned the nation involves a task of education as well as greater effort in industry. Part of the task of education must clearly fall to the Government, which must not cease to explain the significance of the figures for man-power and woman-power displayed in the White Paper on Defence. Part of that task must be discharged by industry as inherent in the establishment of good industrial relations, and there the burden must be shared between management and the trade unions. But part of it must be shared by every citizen who is alive to the challenge of the situation; and great as may be the part of the scientific worker and technician in improving the technical efficiency of industry, they have a no less vital part to play in spreading that spirit of reasonableness, of unprejudiced inquiry and readiness to ascertain and to act on the facts of a situation, which with tact and courtesy can do so much to promote the all-important atmosphere of co-operation and goodwill in industry.

It may well be that the Institute of Management to be established shortly in accordance with the general recommendations of the Committee appointed last November by the President of the Board of Trade and presided over by Sir Clive Baillieu, towards which the Treasury will make a grant of not more than £150,000 over the first five years, will provide some means for bringing together the various parties concerned in raising standards of efficiency. The Institute is intended to provide a centre for the study of management, the prosecution of research and the dissemination of information on the subject of management, as well as to encourage and advise on schemes of training in management; it may be expected that it will also promote the exploration of such new ideas as the efficiency audit, and also establish itself as a professional body. There can be no question that the Institute can make a valuable contribution to the immediate problem of increasing the level of production and to the long-term raising of the

standards of management practice in Great Britain; but to do so it must work in close co-operation with other bodies and enlist the understanding and support of all sections of the community, including not merely the bodies already working in this field—Government departments, public corporations, and private enterprise—but also the trade unions and professional bodies representing the managed rather than the managers.

[1] Industrial Relations in Conditions of Full Employment. By Prof. H. S. Kirkaldy. Pp. 26. (London: Cambridge University Press, 1945.) 1s. 6d. net.

[2] Small and Big Business: Economic Problems of the Size of Firms. By Joseph Steindl. (Institute of Statistics, Monograph No. 1.) Pp. v+66. (Oxford: Basil Blackwell, 1945.) 7s. 6d. net.

THE CLASH OF CULTURES

Man's Most Dangerous Myth

The Fallacy of Race. By M. F. Ashley Montagu. Second edition, revised and enlarged. Pp. xvi+304. (New York: Columbia University Press; London: Oxford University Press, 1945.) 22s. net.

PHYSICAL anthropology got itself into trouble by attempting to divide mankind into sub-groups that were supposed to be, or to have once been, mutually exclusive. Schemes of division based on colour, on hair, on head and face form, on blood groups and so on differ deeply from one another because these various characteristics have different kinds of evolutionary histories. Starting in all probability from a widespread primeval occurrence of brownish skins and wavy hair, evolution has produced darkening or lightening of the skin, crisping or straightening of the hair, according to circumstances of which our appreciation is incomplete. We think the response of head form to circumstances has been less marked and direct, though Ashley Montagu goes further than most thinkers towards accepting Boas' conclusions on changeability of head form, conclusions which were statistical rather than biological.

Ashley Montagu is in agreement with nearly all who study the subject in stating that a classificatory subdivision of mankind is an illusion. One may find evidence for past drifts of mankind carrying certain common features to widely separate regions and gaining certain diversities in other characters on the way. This is not to deny the existence of groups with certain bundles of characters such as tall stature, fair hair, blue eyes and longish heads in Scandinavia; but neither do they make up the whole population of that region, nor are they restricted to it, nor yet are they sharply marked off from other groups; for example, the people with fair hair and rather broad heads so often found in Prussia and East Baltic lands. It often happens that such groups as the above are interesting as historical data. For example, the dark-haired, brown- or grey-eyed, slightly built, long heads of some western parts of the British Isles almost certainly carry the features of some of the people who built the prehistoric monuments of unhewn stone.

But the author is not primarily concerned with such matters; he is deeply moved by the horrors which race prejudice has brought into being, most notably through the Nazi and Fascist criminals, but also very markedly in the United States and in some parts of the British Empire. He pleads against assumptions of superiority of one 'race' over another, and considers that prejudices of this kind are largely of modern growth. One sometimes wonders whether the 'classical education' with its notorious neglect of Eastern thought has not contributed to views about 'the lesser breeds without the law', and even some of the types of religious training among us may have a share of the blame.

Ashley Montagu's thesis is that we should not under-estimate a group because it may have had little or no opportunity. He claims that, with somewhat better opportunities, the coloured man in the northern States of America has forged far ahead of the coloured man of the south, and is often superior, as shown by results of tests, to white groups of the south. He is surely right in feeling that the future of coloured peoples is not to be discounted by complacent—or by panic-stricken—white holders of power and wealth. He sees that we are dealing with feelings, with a 'consciousness of kind' that reacts against the 'unlike', in protection of its real or supposed standards and interests. The feeling against Orientals, including Filipinos, in the western United States, is appropriately cited, and attention is directed to the widespread evil results of fastening a feeling of frustration on coloured citizens of the great democracy which, in theory, claims that all men are born free and equal. Unfortunately, that feeling of frustration is fastened upon many of the under-privileged in most societies and is one of the major social dangers of our time.

The author directs attention to, and might have made still more of, the value of mixtures under reasonably good conditions. It is from mixture of cultural traditions that many of the major triumphs of civilization have come. What does Britain not owe to her reception of religious refugees of the sixteenth and seventeenth centuries, and Holland owes almost more still. Ashley Montagu directs attention to the probability that lack of crossing, and the continuance of homozygotic reproduction, may produce disbalance, a danger carefully watched for among animal breeders even when they continue in-breeding for a while. Crossing may, and often does, produce vigour; but the author devotes only a few remarks to the famous case of the relations of Maori and white in New Zealand.

The last part of the book discusses anti-Semitism, and makes some apt comments. There are widespread 'Jewish' attitudes and gestures, speedily lost by those who slip out of Jewry into the common pool of British or American life. The differences, then, are largely cultural. The ancient population of Jewish Palestine was a medley of peoples including persons of very diverse physiques; some of those who have held to the Jewish tradition have handed on certain physical traits, but there has been much admixture with Europeans before the days of the Ghetto. Neither is there a Jewish race, biologically, nor are the people known as Jews in various parts of Europe and North America of one type; they have in most cases many physical resemblances to the people among whom they live. One recalls the prize the Nazis offered years ago to the most perfect Nordic girl; it was found on investigation that she had a considerable proportion of Jewish ancestry.

The trouble is that the Jews as a distinctive element are only too easily the victims of that reaction against the unlike which is such a common failing, and which has perhaps been increased as men have widened their contacts and have come to meet 'unlikes' more and more. Unfortunately the Jewish

notion of the 'Chosen People' has contributed to the evil result.

Development of communications has changed a collection of many largely self-contained groups into a jostling crowd of two thousand millions. Even within an effort to create a cultural unit, such as the effort in the United States, the jostling crowd of culturally diverse peoples lowers the cultural common measure to danger-point. We must have mixture of traditions and of human stocks for vigour; we must, nevertheless, see that our common measure is raised so that there may be understanding, and with it peace among men of good will.

H. J. Fleure.

VIRUS DISEASES IN PRACTICE

Virus Diseases of Farm and Garden Crops

By Kenneth M. Smith. Pp. 111+16 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 10*s.* 6*d.* net.

GROWERS of many crops are becoming more and more aware of the ravages of virus diseases in field, garden, glasshouse and nursery. Acute observation, beginning nearly two centuries ago, led to the localization of seed-potato production in various places where spread of viruses is low because of relative freedom from their insect transmitters. Control of raspberry and strawberry viruses is now being approached along similar lines, with the separation of susceptible and tolerant varieties as a very practical background. Dahlia growers are alarmed at the incidence of virus in their stocks, and are resolved to maintain the vigour of their ornamental clones by the elimination of such maladies. Gardeners are themselves asking for virus-free shallots.

Dr. Kenneth Smith's book therefore descends very opportunely upon a receptive agricultural and horticultural community. It is a volume more practical in every way than any the author has yet attempted. All that can be said about control is said, though there is no approach to the encyclopædic. Dr. Smith has also addressed himself to the advisory officer, with descriptions of the technique of handling viruses and their insect vectors, of maintaining stocks of the latter, and of methods for testing the identity of some common viruses. This part is a welcome and modern addition to virus literature. Twelve line drawings of the taxonomic features of insect vectors should aid recognition, and the text is plentifully interleaved with good half-tone illustrations of various diseases.

Many crops, in addition to having their 'own' viruses, are attacked by diseases originally described upon other plants. Dahlias, for example, have dahlia mosaic, but are also attacked by tomato spotted wilt and cucumber mosaic viruses. Cross-references in such cases are very frequent in the text.

This volume is, perhaps, more stimulating than its size would imply. It makes one think that the time is ripe for publication of a comprehensive photographic tabulation of virus symptoms on all hosts, with the assessment of symptom complexes caused by more than one virus. This will probably come in time, as much work is already devoted to virus taxonomy by Dr. Smith's own school at Cambridge. The text also makes a reader muse upon the relative feebleness of control measures available at present. They give some practical alleviation of the trouble, but there is nothing comparable in value to control of seed-borne fungus diseases of cereals by organo-mercurial dressings, nor even to spraying the foliage of crops against insect pests. The most promising line of approach to quick eradication of virus in living material is Dr. Smith's suggestion to heat dahlia tubers infected with spotted wilt to 42° C., though even this has yet to be tried.

Such realistic stock-taking is for the research worker, however; the grower will find this volume a good introduction, and the advisory officer or virus technician should have it for constant reference. Dr. Kenneth Smith has maintained the clear, helpful style of his earlier works.

John Grainger.

ECTOPARASITIC INSECTS

Faune de France

43: Insectes ectoparasites (Mallophages, Anoploures, Siphonaptères). Par Eugène Séguy. (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. 684. (Paris: Paul Lechevalier et fils, 1944.) 800 francs.

MOST text-books on general parasitological subjects include chapters on ectoparasitic insects of economic importance, but until now no comprehensive work of reference has been compiled covering those orders of the Insecta the members of which are exclusively ectoparasitic on birds and mammals. It is true that standard works exist which describe the great majority of known species of the sucking lice and the fleas, but these are beyond the reach of the general entomologist except through the libraries. The recent volume of the "Faune de France" series on ectoparasitic insects serves admirably as a treatise for the consulting entomologist and fills a need which has long been felt by those whose duties include a more casual identification of parasites as distinct from their systematic treatment.

The book is divided into three main sections. The first, and by far the largest, deals with the Mallophaga (biting lice), the second with the Anoplura (sucking lice) and the third with the Siphonaptera (fleas). Each section is preceded by a brief description of the chief morphological features distinguishing the group and a general account of the development and habits of its members. This is followed by a systematic treatment of those species infesting the birds and mammals of France. Almost every species is illustrated by line drawings, many of which are original, although it is to be regretted that, in some instances, they have evidently been made from poorly prepared or atypical specimens and are not entirely reliable in detail. These, together with a reference list of the hosts and their parasites and dichotomous keys to the families, genera and species, will be found to be an invaluable aid to identification. The extensive bibliography will be appreciated by those who wish to pursue the subject further. The ectoparasitic members of other orders of the Insecta such as the Pupipara (Diptera) are described briefly and illustrated in an introductory note.

The author is to be congratulated on the wide scope of the work and, in particular, on the section on Mallophaga, which brings under one head descriptions of many species which previously could only be identified by reference to original papers. It is unfortunate that this book, which is likely to prove of considerable use, could not have been printed on more durable paper.

J. E. Webb.

PROTEIN STRUCTURE IN THE LIGHT OF ANALYTICAL CHEMISTRY

THE second Procter Memorial Lecture was given in Leeds on September 21, 1945, before the British Section of the International Society of Leather Trades' Chemists, by Prof. A. C. Chibnall*. Prof. Chibnall referred to Procter's pioneer work on the swelling of gelatin and pointed out that Procter himself took the view that gelatin is a chemical entity with a determinable molecular weight, which he gave as 938 (or some multiple thereof)—a figure obtained by a titration method assuming one basic group per molecule. Procter's own work therefore justified the selection of the subject "The Contribution of the Analytical Chemist to the Problem of Protein Structure" for a lecture to be given in his memory.

The lecture, a most valuable review and summary of work much of which comes from Prof. Chibnall's own laboratory, falls into two parts. The first deals with the new methods now available, and the second with how the results obtained by their use can be applied to the problem of the actual structure of the protein molecule. Two important points are stressed: first, that before confidence can be felt in the determined values of any amino-acid unit in the molecule, results obtained by two different methods must show concordance; secondly, that the only way of knowing how much of the molecule is still evading the analyst's skill is to record the results on the basis of the percentage of total nitrogen. The latter point is so obvious that it can only be the inertia of years of habit that makes most protein chemists still record as 'gm. per 100 gm. protein', a basis that has its roots in the early days of analysis by separation and weighing of the different amino-acid units.

For an accurate analysis, pure material must be available, and a pure protein is not easy material to prepare. The old methods of gravimetric isolation of the amino-acids called for 10–100 gm. of pure material; the colorimetric methods which came later could be carried out with about 1 gm.; the newest methods now available in many cases require only 25 mgm., and the time required for analysis can be measured in hours instead of weeks. The preparation of an adequate amount of pure material has therefore been simplified during the last twenty-five years, but as Prof. Chibnall points out, "because a method is new and possesses many attractive attributes in the technique of working, it by no means follows that it is an improvement on an earlier and almost certainly, in this particular field, a more cumbersome one".

The newer methods fall into eight groups:

1. *Electrophoresis.* This method will separate the basic amino-acids from the others; but it is necessary to dialyse the catholyte three times to be sure that all monoamino-acids are absent.

2. *Ionic Exchange.* The medium is essentially an insoluble acid (or base) which forms insoluble salts. A basic polyamine-formaldehyde resin (Amberlite I.R.4) has been used by Cannan and by Kibrick for the estimation of aspartic and glutamic acids.

3. *Partition Chromatography.* This method, worked out for protein analysis by Martin and Synge, requires only 25 mgm. of protein, and has been particularly valuable in sorting out the monoamino-monocarboxylic acids. The protein is hydrolysed, the mixed amino-acids converted into acetyl derivates, which are separated by partition between two immiscible solvents passing down a column of inert material.

4. *Periodate Oxidation for the Estimation of Serine and Threonine.* This method, introduced by Nicolet and Shinn, is based on the observation that β-hydroxy-α-amino-acids in the presence of periodate react to give ammonia, glyoxylic acid and a free aldehyde. The aldehyde determination can be checked against the ammonia determination. Its use has led to much higher values for serine than the gravimetric isolation method, which was known to be unsatisfactory.

5. *Specific Decarboxyldses.* Gale and his co-workers have obtained enzyme preparations from various bacteria which specifically decarboxylate arginine, histidine, lysine, glutamic acid or tyrosine, with the production of carbon dioxide which can be measured. The enzymes are specific to the natural antipode; and if partial racemization occurs during hydrolysis, results will be too low.

6. *Isotope Dilution.* Rittenberg and his co-workers have explored this method. A weighed amount of the particular amino acid, containing a known excess of N^{15}, is added to the hydrolysate, and then a pure sample is isolated by any convenient method and the isotope content determined. From the ratio of normal to isotopic (N^{14}) amino-acid, the total amount of normal amino-acid in the hydrolysate can be determined. The highly specialized equipment needed for this method has so far put it beyond the reach of most protein analysts, but the results obtained by it should be reliable.

7. *Microbiological Assay.* First introduced in 1943, this method is based on the fact that the growth-response of certain specific micro-organisms depends on the amount of certain specific amino-acids present in the culture medium. To a culture medium, therefore, complete in every respect except the particular amino-acid under investigation, an aliquot of protein hydrolysate is added, and the growth-response measured. Only the natural antipode will be returned by this method, so that if partial racemization has occurred the results will be too low. The method calls for a highly specialized technique, and until more experience of it has been gained a critical attitude towards it is advisable. Micro-organisms do not always behave, generation after generation, like a standard reagent, nor need their behaviour be independent of the general composition of the medium.

8. *Precipitation Methods.* New precipitants for arginine and histidine have been introduced by Vickery, and a new solubility procedure based on partial precipitation by Bergmann and Stein.

The accuracy of these new methods can be judged by comparing the results obtained by analysing known mixtures of amino-acids on one hand, or by comparing the results obtained on one material by several methods on the other. Prof. Chibnall makes a critical review of numerous results obtained in his own laboratory or recorded in the literature, for details of which reference must be made to the original paper. He points out that there is still no accurate method for determining hydroxyproline, and that glycine is a particularly suitable subject for biological methods since the question of racemization does not arise. By describing a difficulty in the determination of lysine that was eventually traced back to a slight and unidentified impurity in the baryta used for

* Chibnall, *J. Int. Soc. Leather Trades' Chemists*, **30**, 1 (1946).

precipitation, he points a warning to all analysts. He then turns to the second part of his lecture, namely, how the structure of insulin and certain other proteins can be deduced from the results of analysis.

A complete (or nearly complete) analysis will, of course, reveal the number of each amino-acid residue present in what Chibnall calls the sub-molecule of the protein, but will give no information as to the distribution along the polypeptide chain. Here a new method of analysis appears, due to Sanger. He finds that in the presence of sodium bicarbonate at room temperature, a condition which does not cause hydrolysis, 2 : 4-dinitrofluorobenzene reacts with free amino groups, producing highly coloured compounds. Subsequent hydrolysis breaks the protein molecule at the peptide links in the normal manner, but does not destroy the brightly coloured 2 : 4 dinitro-phenyl amino-acid derivative. Hence the isolation, identification and determination of these shows which residue (and what proportion of it) was contributing free amino groups to the protein molecule. In the case of insulin, the only coloured products observed were ε-2 : 4 dinitro-phenyl-lysine, 2 : 4 dinitro-phenyl-glycine and 2 : 4 dinitro-phenyl-phenylalanine, each in the amount of two groups per sub-molecule of molecular weight 12,000. Hence it follows that each sub-molecule of insulin contains two lysine residues bound into the peptide chain by the α-amino group but with the ε-amino group free, and that there are in the sub-molecule four peptide chains, two terminating in glycine residues bound in by their carboxyl groups, and two in phenylalanine residues similarly bound. Analysis gives five other glycine and four other phenylalanine residues which must occupy intermediate positions in the polypeptide chains. Titration data suggest twenty to twenty-three base-binding groups per sub-molecule, out of which dicarboxylic acids and tyrosine account for seventeen. Four terminal carboxyl groups would bring the base-binding capacity to twenty-one, which is certainly good agreement. Chibnall therefore considers the evidence overwhelming that the insulin sub-molecule consists of four polypeptide chains differing in constitution and held together by di-sulphide bridges. The evidence for the latter assumption is the presence of twelve cystine/2 residues in the sub-molecule, coupled with a complete failure to detect —SH groups either in the intact protein or the products of hydrolysis.

This conception of the protein molecule is the special contribution of Chibnall and his colleagues to the theory of protein structure. He himself shows that each protein must be approached with a detached mind. For example, the edestin sub-molecule appears to be a single peptide chain terminating in a glycyl group with an apparent minimal molecular weight of 50,000, and there is a possibility that the molecule, which has a molecular weight of 300,000, may consist of five such units and a sixth terminating in leucyl or valyl residues. Again, lactoglobulin, for which a complete analysis has been given by Brand, appears, like insulin, to consist of four chains.

Chibnall leaves, for future investigation, the problem of how the sub-molecules are held together to form the more massive molecules, and to what extent this binding is reversible. Nevertheless, the picture which he presents shows clearly enough that the structure of the protein molecule must be approached with a realization that the massive and complex structure is achieved through order and through degrees of order. Certainly the protein molecule is not formed as the result of an accumulation of amino-acid residues merely characterized by the length of the polypeptide chain. Every residue has its assigned position in the polypeptide chain, every chain its position in the sub-molecule, every sub-molecule its position in the molecule. While much is yet uncertain, the clarification that has come in the last twenty-five years is enormous.

Prof. Chibnall's lucid review will act as an inspiration to all workers in this field, and many people throughout the world will feel grateful to the Society of Leather Trades' Chemists for having selected him to give the second Procter Memorial Lecture.

D. Jordan Lloyd.

ENDOCRINE CORRELATION IN THE EMBRYONAL DEVELOPMENT OF THE VERTEBRATES

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Interest in the function of the endocrine glands during embryonal development in vertebrates arose in connexion with investigations of the role of endocrine factors in the metamorphosis of the Amphibia. Many investigations carried out after the first experiments of Gudernatsch (1909–12) on this problem at the middle of the year 1930 gave sufficiently convincing evidence on the morphogenetic character of endocrine action on the process of larval development of Amphibia. The technical difficulties of endocrine experiments delayed the investigation of this problem in higher vertebrates. Evidence on the role of endocrine factors in the embryonal development of mammals and humans was based mainly on the definite function of the endocrine glands in the embryo : the morphological signs of physiological functional ability, the hormonal contents in the gland, and observations of disorders in the development of the embryo and embryonal abnormalities in the presence of a disorder in the endocrine system. On the basis of these facts, Thomas[1] advanced the opinion that the endocrine glands of higher vertebrates and humans do not act as morphogenetic factors in development during early embryonal stages. Their influence on embryonal development starts only during the later stages, and is of morphogenetic character, that is, they either accelerate or delay the processes of development. However, the majority of endocrine glands, Thomas points out, although endowed with the ability to function at the end of embryonal development, begin their activity only in the post-natal period. This opinion was generally accepted, and the first experiments on embryos were carried out from this point of view.

In 1937, Ancel, at a Conference held at the Collège de France, reported his work on the hypophysectomy of chicken embryos with X-rays during the early stages of development[2]. The investigation of the hypophysectomized embryos showed that their development was entirely normal, including growth and differentiation of the suprarenals, thyroid, parathyroid and sex glands, all of which, as is known, depend in the post-natal period on the function of the hypophysis. These experimental results and the study of pituitary insufficiency in the human and mammalian fœtus led Ancel to assume that no endocrine

correlation exists during the fœtal development of higher vertebrates. This opinion was supported by well-known endocrinologists present at the conference, such as Aron, Selye and Severinghaus.

Fugo and Witschi[8] arrived at the same conclusion after their studies on the hypophysectomized chicken embryo by the micro-surgical removal of the midbrain at the stage of 36 hours of incubation. With the exception of a general delay in growth and slightly impaired thyroid development, they were unable to observe any other changes in the hypophysectomized embryo. They therefore came to the conclusion that the endocrine glands, although playing an important part in amphibian morphogenesis, have no morphogenetic significance in birds.

In 1938[4,5], I published results on investigations of growth after transplantation of the anterior pituitary lobe to the choreo-allantois. At the same time, the reaction of the thyroid gland was studied. Through the action of the transplanted anterior pituitary lobe, the thyroid gland showed an acceleration of morphogenesis. The histological examination of the fœtal thyroid gland showed from the tenth day of incubation clear morphological signs of its stimulation and increased size of the follicles and greater height of the follicular epithelium, rarefaction of the colloid in the follicles and its excretion into the blood. On further investigation[6,7], it was found that the thyroid gland of the chicken embryo responded to the thyrotrophic action of the transplanted pituitary gland already on the eighth day of incubation. At the same time, morphological signs of reaction in the parathyroid gland through the action of the transplanted anterior lobe were observed—increase in size, vacuolization of the protoplasm and increased lipoid infiltration in the protoplasm[5,7]. These investigations show that the thyroid and parathyroid gland can function, if not at the very early stages of embryonal development, then certainly before the completion of some histogenetic processes, and particularly before calcification of the skeleton has taken place, which, in the post-natal period, depends on humoral factors. Simultaneously, it was demonstrated that the first morphological signs of secretion (accumulation and rarefaction of the colloid in the thyroid gland, and rarefaction of the protoplasm, accompanied by accumulation of lipoid droplets in the parathyroid gland) occur in the chicken embryo during normal development on the eighth day of incubation[3]. In the pigeon embryo, which, according to Benazzi[9], hatches with a non-functioning thyroid gland, careful cytological examination reveals signs of function in the hypophysis, thyroid, parathyroid and thymus already on the eleventh day of incubation. Like the chicken embryo, the endocrine glands in the pigeon embryo react to chorio-allantoid grafts of the hypophysis by an increase in size and rarefaction of the colloid in the thyroid gland, and increased lipoid infiltration in the parathyroid gland.

On the other hand, investigations of the structure of anterior pituitary fragments in various stages of growth, as chorio-allantoid transplants, have shown during the first few days a process of depressive character occurs—the degeneration of single cells, disappearance of the colloid (caused by the activity of phagocytes), and formation of plasmodia, owing to the fusion of cells. However, these processes soon revert to a progressive course, producing again the characteristic structure of the anterior pituitary lobe, with all typical cells and reappearance of colloid, the only difference being that the histological picture of the glands on the whole appears similar to the embryonal structure of the hypophysis. This structure is preserved in the graft for a long time, even on subsequent transplantation into another egg, by which one can culture transplants for a period of thirty days or more. The hypophysis always responds to failure of the thyroid gland by the development of characteristic thyroidectomy cells of degenerative character, and their absence in the graft is therefore proof of thyroid function in the embryo in which the chorio-allantoid transplant grows. These results, obtained in 1938, represented convincing evidence of the endocrine correlation in the embryo. Hence doubts have arisen as to the correctness of the conclusion of Ancel[2] and Fugo and Witschi[3], that no endocrine function occurred in the embryo[11].

Subsequent experiments on the hypophysectomy of the chicken embryo, according to the methods of Fugo and Witschi, justified previous doubts on this question. In 1940, Fugo[12] published new investigations on the effects of hypophysectomy in the chicken embryo; these resulted in delay of growth, inhibition of plume development and its pigmentation, in delayed differentiation of the thyroid and parathyroid gland, testes and a few other changes in the operated embryo. In 1941, Martindale[13] confirmed the reported effects of hypophysectomy on the chicken embryo, according to the method of Fugo and Witschi, and found the period when the hypophysis first starts to exert an action on the thyroid gland. It was found that the transplantation of the non-differentiated thyroid gland of the hypophysectomized embryo to the chorio-allantoic membrane of the normal embryo started its normal development on the eleventh day of incubation. On the basis of these important experiments, Martindale concluded that the thyroid gland begins to react to the pituitary thyrotropic hormone on the eleventh day of the development of the chicken embryos.

Simultaneously with Fugo and Martindale, experiments on the transplantation of chicken embryo pituitary grafts to the chorio-allantois were carried out in order to observe its hormonal activity. The hypophysis was removed from the chicken embryo at about the 8th–21st day of incubation, and was grafted on to the chorio-allantois of a 7–10-day-old chicken embryo. The investigation of the embryo subjected to the action of the transplanted embryonal hypophysis showed that the hypophysis from embryos at the age of ten days and more exerts on the thyroid gland of the recipient a very marked thyrotropic action. The follicles enlarge to an extent which during normal development is only observed after the chicken is hatched. Rarefaction of the colloid takes place and in some cases it is almost entirely excreted into the blood. The cells of the follicular epithelium in single cases are two and a half times greater in height than the cells in the corresponding control embryos.

The action of the transplanted hypophysis from 8–9-day-old embryos is less marked, but still leaves no doubt as to the morphological signs of the reacting thyroid gland. The parathyroid gland reacts to the transplanted hypophysis by rarefaction of the protoplasm, showing vacuolization on the fixed slides and increased lipoid infiltration. The thyroid, as well as the parathyroid gland, reacts to the transplanted hypophysis by an increase in size.

On the basis of the experimental evidence, it is possible to arrive at the conclusion that the characteristic relationship between the hypophysis and the

thyroid, as well as the parathyroid gland, establishes itself in the chicken embryo simultaneously with the histological differentiation in these glands, that is, on the ninth day of incubation.

What is the role of the endocrine glands during embryonal development? It is quite evident that in the development of the higher vertebrates, the stages corresponding to amphibian metamorphosis cannot be under the control of the thyroid gland and hypophysis, as the morphogenesis of these glands only takes place later. It is also clear that the endocrine glands take no part in the process of determination of the main organs in the embryo, as the differentiation of glands only starts after the process of organic determination is completed.

On the other hand, the embryonal histogenetic processes at the stage of early differentiation of the endocrine glands are not only unfinished, but many of them have not even started, as, for example, the histological differentiation of the integument, skeleton and other tissues. The influence of the endocrine factors on the differentiation of these tissues is very probable, and may be regarded as proved by the experiments of Fugo on the formation of plumage. On the other hand, the comparatively weak effect of hypophysectomy on the basic morphogenetical processes in the chicken embryo leaves unsolved the role during embryonal development of the hypophysis and of the endocrine glands under its control.

Considering all the evidence on the function of the endocrine glands in the physiology of the higher vertebrates during the post-natal period, it is not difficult to realize that their regulatory functions dominate significantly the morphogenetical functions.

Clearer still is the morphogenetical role of the sex glands, the secretory function of which causes the development of secondary sex characteristics. The role of the thyroid gland in the formation of feathers in birds is also very clear. All other glands take part in the exceedingly complicated and inter-connected function of regulating the basal metabolism in the organism. Furthermore, it is not difficult to note that these regulatory functions are mainly concerned in preventing in the organism any disturbance in the balance of metabolism, which might be caused by internal changes. Owing to the constant requirements of the organism, no regulation of the flow of nutritional substances from within would be required if the cell metabolism in the organism were constant. However, cell metabolism in the organism changes continuously; yet the relatively constant internal activity as regards composition of food and physical reaction greatly decreases the need for the endocrine regulation of the basal metabolism in the internal environment of the organism. Adrenalin and thyroxin are mobilized in the warm-blooded organism for heat regulation only in cases of external temperature changes.

Hyperfunction of the parathyroid gland is only noted in cases of marked calcium deficiency in the organism, due to rickets or to lack of calcium in the food. The pancreas, as the regulator of carbohydrate metabolism, functions more intensely when the amount of carbohydrates in the food increases and if increased work causes a greater requirement of carbohydrates by the cells. The endocrine glands concerned with the regulation of water metabolism—the hypophysis and thyroid gland—participate in the preservation of an optimal water content in the cell protoplasm, and in the internal environment of the organism, solely due to the fluctuating content of water in the food and to changes in the formation of urine taking place on account of changes in the activity of the organism.

The embryonal organism of the higher vertebrates develops under constant and optimal condition of its surrounding environment.

The need for endocrine regulation of possible disorders occurring during the normal establishment of metabolic balance is limited. On this account, and in spite of the fact that the embryonal endocrine organs are morphologically able to function, their activity is very slight, and only observed under experimental interference. The embryonal endocrine system must be regarded as a potent regulatory mechanism, ready to participate in the process of development as soon as needed. However, under optimal conditions of development, it functions only to a very limited extent.

It is known that the thyroid gland in birds participates in heat regulation, showing signs of hyperfunction at a lowered temperature. It was possible to demonstrate that by cooling eggs during incubation, signs of increased thyroid function in the embryo at the 13th–16th day of incubation occurred, due to stimulation of the gland.

Calcium metabolism of higher vertebrates is regulated by vitamin D, and the hormone of the parathyroid gland. Vitamin D participates in the assimilation of calcium by the organism, and maintains the relation between calcium and phosphorus necessary for the normal calcification of the skeleton, and causes the migration of calcium from the internal medium into the main calcium depot of the organism —the skeleton. The hormone of the parathyroid (parathormone) maintains the normal blood calcium level, and, to a certain extent, antagonizes the action of vitamin D by mobilizing in case of necessity calcium from the calcium depot—the skeleton. It was possible to observe that on the eighth day of incubation, when the calcification of the skeleton in the chicken embryo begins, and consequently the internal medium becomes poorer in calcium owing to its deposition in the skeleton, the parathyroid gland frequently shows signs of stimulation—increased rarefaction of cell protoplasm.

In this manner, in some cases of normal embryonal development, the necessity for increased function of the endocrine glands may arise. Simultaneously, the increased endocrine function may exert its action on the morphogenesis and differentiation of the embryonal organs and tissues. Primarily this applies to the bone tissue, the histogenesis of which takes place at a period when the morphological differentiation of the anterior pituitary lobe, thyroid, parathyroid and thymus can already be observed. The observation of the morphological changes in the skeleton of the chicken embryo under the action of chorio-allantoid pituitary transplants proves this hypothesis. Development and growth of the experimental embryos is delayed; and frequently they show signs of abnormal skeleton formation, known as 'chondrodystrophy'. In the more acute forms, the disturbance of skeletal development shows signs of arrested cartilaginous growth, with delayed ossification and calcification, which causes shortening of the tubular bones and flexion under the action of muscular tonus. In the experiments carried out, the development of typical chondrodystrophy occurred mostly during the winter months, comprising approximately 25 per cent of all experimental embryos. A small percentage of chon-

drodystrophic development has been observed also in the control groups, but exclusively during winter time and not exceeding 5 per cent.

The appearance of chondrodystrophy in chicken embryos is morphologically well understood. It resembles the human disease known as achondroplasia fœtalis, and is characterized by abnormal shortening of the extremities and pathological changes of the skeleton. The etiology of this disease is unknown.

In the study of experimental chondrodystrophy, the following facts were taken into consideration. Landauer[14] noted the shortening of bones and disorder of skeletal formation in embryos and hatched chickens following a deficient food regime of the egg-laying chicken. The development of chondrodystrophy in the experimental chickens, as well as in the controls, mostly takes place during the winter months. This fact leads to the assumption that the cause of the disease is connected with a deficient diet, mainly as it appears owing to a deficiency of vitamin D—the regulator of calcium metabolism. In fact, the yolk of the chicken egg is, during winter, five times poorer in vitamin D than during the summer; and in some cases it may be insufficient for the maintenance of a normal blood calcium level and for normal calcification of the skeleton.

Incidentally, stimulation of the parathyroid gland can lead to drastic inhibition of calcification, and to abnormal development of the skeleton. The effects of the parathyroid hormone on the skeleton of the growing organism are well understood. It is known that large doses of parathormone cause decalcification of the skeleton, inhibition of cartilaginous tissue development, and epiphyseal degeneration of the bones[12]. It is most probable that chondrodystrophy is due to increased function of the parathyroid gland, caused by D-avitaminosis in the embryo. The results obtained with anterior pituitary lobe transplants may be explained from this point of view. The transplantation of the pituitary gland stimulates the parathyroid gland. This effect was observed and investigated morphologically on a large scale[8]. The stimulation of the parathyroid gland causes a flow of calcium from the tissues into the internal media of the organism, producing impoverishment of calcium in the skeleton. During the summer, the large amounts of vitamin D contained in the yolk of the egg easily counteract this impoverishment, stimulating the flow of calcium in the reverse direction. During winter, the amount of vitamin D is insufficient to counteract the hormone excreted by the parathyroid gland. As a result, severe disturbance in the skeletal development takes place with its decalcification and deformation.

Studies of the interrelationship of the endocrine glands in the causation of experimental chondrodystrophy, taking into account the influence of the vitamin D balance, prove almost certainly the hypothesis of the humoral nature of this disease. On the basis of the evidence at hand, it is possible to conclude that the function of the endocrine glands during fœtal life is insignificant only under the optimal environmental conditions in which the fœtal organism develops. As soon as a deviation from the optimum occurs, the endocrine system can be mobilized as one of the most important regulators of vital functions in the organism. In certain cases, the endocrine apparatus re-establishes the disordered balance and secures normal development. In other cases, when the balance is severely disturbed, as for example in deficiency of vitamin D (never noted in birds propagating during the summer), disorder in the normal development occurs with possible aberrations in morphogenesis.

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NUTRITIONAL VALUE OF BEER*

By Dr. F. W. NORRIS

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FROM the days when prehistoric man first observed the 'fervent' liquor and experienced the after-effects of a possibly too-potent brew, alcoholic beverages have played an important part in social history. The desire for variety in what we drink manifests itself at an early age, as evinced by the child's preference for coloured and 'fizzy' drinks. As an adult he frequently acquires a taste for a drink which in Britain justifies the term 'national beverage', namely, beer. With social aspects we are not here concerned; as in a number of other cases, while moderation is harmless and even beneficial, excess is disastrous. None will dispute that the cause of true temperance, ably abetted by H.M. Commissioners of Excise, has made enormous strides.

As beer occupies so important a place in the national economy and is often a normal constituent of the diet, it is not surprising that it has attracted the attention of the nutritionist. In recent years the science of nutrition has made important advances, and it is not unprofitable to consider beer in their light.

The nutrients which may finally appear in beer must obviously derive from the materials of the malting and brewing process, and from the biochemical actions which occur. The most important materials are barley, from which the malt is made; malt adjuncts such as maize and rice, which mainly provide additional starch; hops, yeast, sugars and brewing waters.

The essential reactions which occur in the malting of barley and the mashing of malt are enzymic in character. The starch in barley is of vital importance to the brewer since it is the basis of his extract, and largely provides the material for fermentation. In malting and mashing, it is converted by the appropriate enzymes to soluble dextrins and sugars, and by a somewhat analogous process the proteins are also largely converted to soluble products. At the boiling stage, two important changes, among many, occur: the addition of hops provides important antiseptic substances; and a proportion of the nitrogenous substances are coagulated. In fer-

* Based on lectures on the general subject of the nutritive value of beer, given jointly by Dr. F. W. Norris and W. J. Stringer in London; and by Dr. F. W. Norris in Edinburgh and Birmingham, under the auspices of the Society of Chemical Industry, and Institute of Brewing, during December 1945 and January 1946.

mentation there is a loss of some 50 per cent of the solid material of the wort. The carbohydrates are largely fermented to alcohol and carbon dioxide; many of the simpler nitrogenous substances are lost to the yeast, being necessary for its satisfactory growth.

So far, then, as solid material is concerned, the story of the malting and brewing process is one of loss; but the loss is not absolute, since, for example, the sugars are converted to alcohol. Starting with an average barley containing some 60 per cent of starch and 10 per cent of protein, the finished beer may contain about 3 per cent of carbohydrate, 0·2 per cent of nitrogenous substances, and 3 per cent of alcohol.

The carbohydrates consist of degradation products of starch, and there is no reason to suppose that they are not digested in the normal manner. Their amount is not large, but they do provide nearly half of the energy value of the beer. The nitrogenous material is much smaller in amount, but this also is digested. Little information is available as to the precise nature of these substances; it would be interesting to know if they include any of the essential amino-acids. Such information may be forthcoming as the result of application of microbiological methods of assay of amino-acids.

Whereas beer as a whole may be regarded as a food since it contains four out of the five classes of nutrients, the alcohol which it contains may be regarded as a nutrient only in a strictly limited sense. It acts solely as a more or less immediate source of energy, and has none of the other functions ascribed to a nutrient. It is a substance foreign to the economy of the body, which eliminates it as soon as convenient. Thus, it is readily absorbed in the stomach, and provided the amount is not excessive, fairly rapidly oxidized in the cells. On an energy basis it can, of course, replace *pro rata* other energy-producing nutrients; but this seems a somewhat academic point, since beer is taken as a beverage in addition to the normal diet by most people.

As beer contains no fat, the calorie value may be calculated by multiplying the total solids (virtually carbohydrate and protein only) by 4, the alcohol content in grams by 7, and adding the two products together. It will then be found that the calorie value is derived, frequently to the extent of more than 50 per cent, from the content of alcohol, that it ranges from about 120 calories per pint for the mildest ales, to about 400 calories per pint for the strongest, and that it bears a close relationship to the specific gravity of the wort prior to fermentation —the 'original gravity'. For example, a beer of original gravity 1,033·2 (water = 1,000) would have a calorie value of $(1{,}033{\cdot}2 - 1{,}000) \times 5{\cdot}25 = 174$ calories per pint. The experimental value in this case was 177. Thus, by taking the excess of the original gravity over 1,000 and multiplying by the factor 5·2 or 5·3 (5·25 was chosen above as the mean of these two factors) a reasonably accurate estimate of calorie value may be obtained.

It is desirable to stress that this is the calorie or *energy* value and not the *nutritive* value of the beer. It is misleading and erroneous to compare different foods solely on an energy basis; all the nutrients in a food must be compared when assessing nutritive value.

Of the minor but essential constituents of the diet there remain the mineral salts and vitamins. Mineral salts derived from the waters, the materials and possibly the utensils used in brewing are present in the beer. It is a brewing commonplace that the nature of the water plays an important part in determining the nature and quality of the resultant beer. It was largely by reason of the characteristics of the local waters that London and Dublin became famous for stouts and porters, and Burton-on-Trent for pale ales. There is a very complex interplay between the various salts present during the brewing process, and the nature of the salts found in the finished beer depends on a number of physico-chemical factors not all of which are clearly understood.

The valuable salts of calcium are present in beer in very variable amount according to type and conditions of brew. In a number of analyses recently examined, the lowest content appeared to be of the order of 25 mgm. of calcium per pint, the highest about 270 mgm. per pint. The ratio calcium/phosphorus appeared to average unity for a wide range of beers and stouts, and this ratio may be regarded as satisfactory. On the basis of a daily requirement of 800 mgm. of calcium, it will be seen that one pint of beer might provide about 10 per cent of this.

At the present time it is not possible to say what proportion of calcium and phosphorus in beer is absorbed by the body. It is known that beer contains phytic acid derived from the grain, and investigation is proceeding whereby an accurate assay of this substance may be made. The estimation of the various fractions of organic phosphorus—hexose phosphate, phytic acid, etc.—is not at present on a satisfactory basis, and until accurate methods are available it would be invidious further to discuss the phytic acid question. Phytic acid is not itself absorbed by the body, and in addition it takes up a certain proportion of calcium (and iron) which is similarly lost. In the absence of quantitative data, it is nevertheless reasonable to point out that not all the calcium and phosphorus in beer is necessarily absorbed.

Of the other nutritionally important minerals, copper in small amount, and manganese are known to be present in beer. Sodium chloride and potassium salts also make in this way a useful contribution to the diet of heavy workers, or workers in heated atmospheres who tend to lose abnormal amounts of these salts by perspiration or excretion.

The story of vitamins in beer is a somewhat chequered one. It starts in the early days of vitamin history and at a time when the complex nature of vitamin B was not realized. Examination of barley and malt led to the belief that although vitamin B might be present to a small extent in these products, the amount in the finished beer was so small that it could be disregarded. It is interesting to note that at this time vitamin C was found in germinating cereals and pulses, and was thus present in barley on the germinating floor of the maltster. It does not, however, survive the subsequent kilning and brewing processes, and is not a constituent of beer, although claims to that effect were made so recently as 1935.

Following the earlier disappointing results, interest in vitamins in beer waned, and it is only quite recently that it has revived, threatening at one time to become 'a seven days wonder' in the popular Press. In the intervening period, the complexity of vitamin B had been realized, and at the present time there are not one or two, but ten or eleven members of the group, and still more are likely to be established. Moreover, the accurate assay of the various members of the complex has been a primary objective for many laboratories in Great Britain and the United States. The methods employed are three in type:

biological, microbiological and physico-chemical. Each has its difficulties and is being subjected to intensive study by teams working in collaboration. Although results in some cases leave something to be desired, important advances have been made, and it is now possible to assay with some degree of accuracy the most important members of the complex.

The application of such methods to brewing materials and processes is a recent development, and it is now known that several members of the vitamin B complex are to be found in beer, in amounts which may have some dietary significance. Detailed investigation has so far been devoted to aneurin, riboflavin and nicotinic acid. Other members of the vitamin B complex are under examination, and findings are likely soon to be published. These include pantothenic acid, pyridoxin and biotin; but their position with reference to human nutrition in general still needs some clarification.

In the case of aneurin, there is some loss when barley is malted, but little change in mashing and boiling. In fermentation, however, a remarkable change takes place, most of the aneurin in the wort being taken up by the yeast at the expense of the beer, which cannot therefore be regarded as a very good source of the vitamin. The amounts reported, in μgm. per pint, range from about 7 to 35, and contents as high as 85 have been found in certain strong ales.

With regard to riboflavin, there is increase both in malting and in fermentation, many yeasts having the power of synthesizing riboflavin, with the result that the beer contains appreciable amounts and the yeast crop is greatly enriched. The riboflavin content of beers ranges from 200 to 800 μgm. per pint, the higher limit being attained only by some strong ales.

Nicotinic acid is also present in appreciable quantity; derived like the others from the original barley, there is some increase in malting, after which the subsequent processes involve slight losses. Yeast appears neither to synthesize nor take up significant amounts of the vitamin. Finished beers contain from 2 to 11 mgm. per pint, with an average of 5 or 6 mgm.

The three vitamins discussed above are known to have important relations to carbohydrate metabolism in that they are constituents of enzymes concerned. It should be remembered in this context that the carbohydrates (and nitrogenous substances) in beer make their own demands on these vitamins, and only after such demands are met will the balance of the vitamins make a positive contribution to the general diet. It is difficult accurately to assess such contribution; but it is safe to suggest that a moderate consumption of beer increases the vitamins generally available, at least so far as riboflavin and nicotinic acid are concerned.

The antiseptic and other constituents of hops, while important as agents which give beer some of its pleasing characteristics, are of no direct nutritional significance; but it should be mentioned that the presence of these substances and the conditions of manufacture render beer, from the microbiological point of view, one of the safest of our beverages.

There would seem to be a case for a systematic study of the constituents of beer in relation to modern views on nutrition. While the results of this would be interesting and even important, it has to be admitted that in this case—as in many others—the public consumes the product primarily because it likes it.

OBITUARIES

Dr. F. W. Lanchester, F.R.S.

Dr. F. W. Lanchester died at his home in Birmingham on March 8, and the world of engineering lost a figure of the type which is perhaps only just beginning to be appreciated—a great physicist who applied his knowledge and critical mind to engineering problems. He was born on September 23, 1868, was educated privately and received his scientific training at the Royal College of Science, South Kensington. His earlier days were devoted to the automobile world, and he is generally credited with having produced the first motor-car driven by an internal combustion engine in 1895–96. He certainly founded the Lanchester Motor Co., Ltd., in 1899, and the firm's first product contained many unique features typical of his genius and unorthodox views. He was afterwards associated with the Daimler and B.S.A. companies, and then took up the compression ignition engine with Messrs. Beardmore, which activities lasted up to 1930.

Since 1930, Lanchester has been a free-lance consultant, and has often surprised those who were privileged to know him by the breadth of his interests. Unfortunately, he was attracted only by the academic interest of problems, and it usually fell to others to reap both the credit and the financial rewards of his original thinking. Lanchester had too big a mind to allow this to deter him, although the unfairness of it sometimes led him into controversies that have often caused him to be labelled 'difficult'. It has been said of him that "his brilliance blinded those around him and some never recovered from their blindness". An extremely sensitive nature made it impossible for him to fight even for his just rewards, still less to accept anything that carried a suggestion of charity, and consequently he died really poor.

Lanchester's name will be honoured, perhaps more than anywhere else, in the world of scientific aeronautics. He presented papers to the Birmingham Natural History and Philosophical Society in 1894, and to the Physical Society in 1897 on the subject of aerofoil theory, the concepts of which are to-day firmly established as the theory of lift and drag. His two volumes, "Aerial Flight, Aerodynamics and Aerodonetics", published in 1907, laid the foundations of the theory of flight that remain uncontradicted and accepted everywhere to-day. This work, afterwards elaborated by Dr. L. Prandtl of Göttingen, is to-day known as the Lanchester–Prandtl theory, and this circulation theory is accepted universally as the basis of modern aerodynamic science. In 1916 he published a book entitled "Aircraft in Warfare", which was a reprint of a series of articles contributed by him to *Engineering* before the outbreak of the First World War. Many of the precepts that he laid down there have since become the commonplaces in warfare. Some of these, notably the airborne torpedo and the use of the naval aircraft carrier, only received their full recognition and development in the Second World War. During late 1939 and early 1940, *Flight* published what was probably some of his last scientific writing, entitled "Exhaust Efflux Propulsion", laying down a scientific basis of jet and rocket propulsion. The trend of development in these matters is already showing that his pioneering thought upon this subject is likely to prove as fundamentally correct as his other aerodynamic work.

In addition to the writing of books and articles, Lanchester was a member of the original Advisory

Committee for Aeronautics, the forerunner of the present Aeronautical Research Council, during 1909–20, and it is impossible to measure the full extent of his advice and guidance in that body. He was a past-president of the Institution of Automobile Engineers, and held all three medals, the bronze, silver and gold, of the Royal Aeronautical Society. He delivered the Wilbur Wright Memorial Lecture to that Society in 1926.

Perhaps only those who were privileged to be intimate with Lanchester knew that he was also a poet, and had published two volumes of verse under the name of 'Paul Netherton Herries'.

The debt that the world of science, particularly aviation, owes to Lanchester has never been fully acknowledged, and it is a melancholy fact that we have had to wait for his death to prompt some of his associates to suggest the institution of some form of memorial to his memory. F. T. HILL.

Mr. Alfred Lucas, O.B.E.*

'BENCH-MARKS' established by Lucas are to be found in such various fields as the study of ancient and modern Egyptian materials and industries, the soils and waters of the Nile, the preservation and reconstruction of Tutankhamun's treasures, trials and courts-martial, and the route of the Exodus. He was a pioneer of modern science in Egypt, alert and precise, applying the severe discipline and manipulative skill of analytical chemistry with so deep a comprehension of essentials that he was neither dilettante nor don. Kindly to ignorance but merciless to fraud, he made even his smallest contributions into facts of historical importance for students of the many subjects which he illuminated. His encyclopædic local knowledge was conspicuously useful to England on the Scientific Advisory Committee to G.H.Q., M.E.F., especially during 1940–42, when Service supplies had often to be improvised locally. At the age of seventy-eight, while about to attend a commission on the state of the Theban tombs, he died in Luxor on December 10.

Lucas was born at Manchester on August 27, 1867, and went from private schools to the Royal College of Science and School of Mines in London. After eight years as assistant chemist at the Government Laboratory in London, he went to Egypt in 1897 for reasons of health. Egypt's climate arrested his tuberculosis, and in May of 1898 he joined the Salt Department as chemist under Mr. A. H. Hooker. A year later he left voluntarily when this department became the Salt and Soda Company, to be chemist to the Survey Department under Captain (later Colonel Sir Henry) Lyons in March 1899. Lyons built a small three-room laboratory in the garden of the Public Works Ministry, to which the Survey then belonged, and put Lucas in charge. The laboratory grew rapidly beyond its original purpose of analysing minerals; in 1912 it took over and re-organised the Assay Office, becoming a separate department called the Government Analytical Laboratories and Assay Office, with Lucas as director. Later it became the Chemical Department. Lucas resigned voluntarily on reaching the minimum age limit in March 1923. For help given by these Laboratories to the military authorities during 1914–18 he was awarded an O.B.E.; from Egypt he received the third order of the Nile, and the fourth of the Osmania.

Retirement meant only that Lucas continued his favourite pursuits with renewed vigour, and in the following months he was attached to the Antiquities Department, as chemist, until 1932. His services were lent to Howard Carter for cleaning and preservation work on the wealth of objects which had been found in the tomb of Tutankhamun, and for nine winters Lucas lived and worked at Luxor on them. The rest of each year was spent on other work at the Museum in Cairo. He helped to put the seventeen hundred objects on exhibition and, years afterwards, to store them against possible bombing and to bring them back to the exhibition rooms. His diplomatic abilities were freely exercised during those nine years. In 1932 his contract was not renewed, so he remained at the Museum doing voluntary work until December 1934, when he was given official status again with a small salary, after which he became honorary consulting chemist.

Apart from numerous contributions to chemical and archæological journals, Lucas published three books which are in steady demand. "Antiques, their Restoration and Preservation", in two editions, incorporated his practical experience and many devices. "Forensic Chemistry and Scientific Criminal Investigation" ran to four editions and a reprint; it revises several accepted beliefs, especially in ballistics. He had a wide experience as an expert witness, and during most of the Second World War he averaged two courts-martial a week, British or American, in spite of long-standing angina pectoris; he was not a witness to browbeat, for in pursuit of truth he would be outfaced by no man.

The third book, which is proceeding to a post-humous third edition, is perhaps Lucas' most important one. "Ancient Egyptian Materials and Industries" is amazing in its accuracy, fully documented with reference to every detail (though he was his own secretary) and gives short shrift to any archæological mis-statements. The direct experimental work which he had done for checking purposes ranged from mummification to the re-discovery of faience manufacture.

A small book on the "Route of the Exodus" is interesting as an example of close reasoning on topography, meteorology, and probability applied to the account given in the Old Testament. Two delightful little booklets on the history of Egypt and Libya were printed and distributed free to military clubs and hospitals during the War.

Scarcely any learned man did more for the troops in the Middle East during the War, showing them the interests which exist behind the unattractive modern façade of Egypt, by broadcasts, lectures, and demonstrations. All this was done at his own expense, and he told with glee how, for one appointment at a far-off camp during the early days, he was fetched in a loaded lorry but sent home in a staff car. His first broadcast lecture had been when the trumpets of Tutankhamun were heard by the world in April 1939. Taking parties of 'other ranks' through the Cairo Museum after it re-opened was one of his chief pleasures, with willing answers to every possible kind of question.

The scope, volume, and quality of his scientific work is realized by only a few of us, but it will be many years before research workers can afford to overlook any of his careful results and his balanced opinions.

W. L. BALLS.
The late R. ENGELBACH.
D. S. GRACIE.
H. E. HURST.
L. F. MCCALLUM.

* See also *Nature*, Jan. 26, p. 98.

NEWS and VIEWS

Botany at Manchester

Prof. J. M. F. Drummond

PROF. J. M. F. DRUMMOND, Harrison professor of botany and director of the botanical laboratories in the University of Manchester, retires at the end of the current academic session. Prof. Drummond was educated at King's College, London, and at Gonville and Caius College, Cambridge. At Cambridge he held the Frank Smart Research Studentship during 1904–6. His first academic appointment was at Armstrong College, Newcastle-upon-Tyne, where he was lecturer in botany during 1906–9. He then transferred to the University of Glasgow, where, under Prof. F. O. Bower, he was lecturer in plant physiology from 1909 until 1921. Then for four years he was director of the Scottish Plant-Breeding Station, being the first director of that Institute. In 1925, he was appointed to succeed Prof. Bower as regius professor of botany in the University of Glasgow, and in 1930 transferred to the Harrison chair at Manchester. Prof. Drummond's outstanding published work was his translation from the German of Haberlandt's "Physiological Plant Anatomy", a book which for years had considerable influence on the development of plant anatomical studies. But it is certain that Prof. Drummond's greatest influence lay in his encouragement of young research workers and lecturers under his charge. Nothing in this connexion was ever too much trouble for him, and there are many present-day botanists and others who owe much to the sympathetic interest and practical support of Prof. Drummond in the formative years of their professional careers. Prof. Drummond also had a brilliant military career during the First World War, and during the second was an enthusiastic worker in charge of the Manchester University Contingent Senior Training Corps.

Prof. Eric Ashby

PROF. ERIC ASHBY, who has been appointed to succeed Prof. Drummond, was educated at the City of London School and at the Imperial College of Science and Technology, where he was Forbes medallist. As a Commonwealth Fellow he worked at Chicago, the Desert Laboratory at Tucson and at Hawaii. In 1931 he was appointed lecturer at the Imperial College, and in 1935 he went to Bristol first as lecturer and later as reader in botany. In 1938 he was appointed to the chair of botany at the University of Sydney. Almost throughout his time in Australia he has been fully engaged in the organisation of scientific work in connexion with the War and, during the past year, he has been in the U.S.S.R. on a scientific liaison mission (*Nature*, 155, 72; 1945). In his research work a strong mathematical bias led him to apply, with success, statistical methods to the problems of ecology; but he has been chiefly concerned with the physiology and genetics of the processes of growth and development. Early work produced elegant studies on the growth of *Lemna* under controlled conditions. Later he made original contributions to our knowledge of the mechanism of hybrid vigour. A man of great energy and of incisive and original mind he has a most stimulating influence on his friends and students. He will bring to his new post the experience of wide travel and generous sympathies. His return to Britain will notably strengthen botanical teaching and research in this country.

The Engineer: Retirement of Mr. L. St. L. Pendred, C.B.E.

ON April 1, Mr. Loughnan St. L. Pendred retired from the editorship of the *Engineer*, a post he has held with distinction for forty years, having in 1905 succeeded his father Mr. Vaughan Pendred (1836–1912), who had also been editor for forty years. The *Engineer* was founded in 1856, and Mr. Vaughan Pendred in 1865 succeeded the unusually talented but somewhat erratic engineering genius Zerah Colburn (1832–70) who, in 1866, founded *Engineering*. Mr. Vaughan Pendred, who was born in the county of Wicklow, in 1862, married Miss Marian Loughnan and went to England shortly afterwards. Before joining the *Engineer*, he edited the *Mechanics Magazine*, then the most important journal in Britain devoted to things mechanical. Mr. Loughnan Pendred was his second son, and was born in 1870. Educated at the Central Institution, South Kensington, and at Finsbury Technical College, where he came under the inspiring influence of Silvanus Thompson, John Perry and H. E. Armstrong, he gained practical experience at Colchester, Ghent and on the old Western Railway of France, and during 1893–96 he was employed in the ordnance department of Sir W. G. Armstrong, Mitchell and Co., at Elswick. He then joined his father in the office of the *Engineer*, and at the age of thirty-five succeeded to the editorial chair.

Apart from his work for the famous engineering journal, Mr. Pendred is best known for his activities in connexion with the Institution of Mechanical Engineers, of which he is now an honorary member. He was president of the Institution during 1930–31, represented it at the fiftieth anniversary celebrations of the American Society of Mechanical Engineers and in 1934 delivered the Thomas Lowe Gray lecture, "A Survey of Ships and Engines". The first illustration in this lecture is from Robertus Valturius, 1472, an indication of Mr. Pendred's love of history, which has made him a valuable member of the Newcomen Society. It was in his office on June 4, 1920, that the Society made its debut. He has twice served as president and his address on October 26, 1923, was on "The Value of Technological History". He has also served as president of the Institution of Engineers-in-Charge, and is an honorary member of the Junior Institution of Engineers. During his long editorship of the *Engineer*, he has introduced many improvements, and it fell to him to guide its fortunes through two great wars. Among his friends he is known as the best of hosts and as the maker of delightful models and machines. His services to the engineering profession were recognized by the award to him in 1934 of the C.B.E. He is succeeded in the editor's chair by his second son, Mr. Benjamin Pendred, who will have the assistance as consultant editor of Dr. T. W. Chalmers, who has been associated with the journal since 1909.

Stopes Medal of the Geologists' Association: Award to Mr. A. S. Kennard

ON March 1 the Henry Stopes Memorial Medal for work on prehistoric man and his geological environment was awarded at the annual general meeting of the Geologists' Association to Mr. A. S. Kennard, retiring president of the Association. The choice of the first recipient had been entrusted to Henry Stopes's daughter, Dr. Marie Stopes. The new president, Mr. C. N. Bromehead, immediately after

taking office, announced the founding of the medal in commemoration of Henry Stopes; after mentioning Stopes's work on prehistoric man and Pleistocene geology, he called upon Dr. Marie Stopes, herself a pioneer in certain branches of geology, to make the presentation. She alluded to Mr. Kennard's varied work on this subject and, in particular, to the debt which many prehistorians owe to him for his detailed study of the contemporary land and freshwater mollusca as indicators of climatic and other environmental factors. The next award of the medal, the only one in Britain given for prehistory, will be in 1949, when, at the express desire of the donor of the fund, all members of the Geologists' Association will have a vote in the selection of the recipient or joint recipients.

Two Notable Geomagnetic Storms

DISTURBANCES of considerable intensity, comprising two distinct geomagnetic storms, occurred during the interval March 23–29. Displays of the aurora borealis have been reported; there was dislocation over long-distance radio channels and, in the case of the second storm, with submarine-cable telegraphy. The Astronomer Royal has given the following provisional data: ranges in the three elements (*D*, *H* and *V*) of the earth's magnetic field as recorded at the Abinger magnetic observatory during the three 24-hour intervals commencing March 23 at 11h. U.T.

	D	*H*	*V*
March 23–24	0·9°	300γ	180γ
" 24–25	0·8	230	400
" 25–26	1·5	430	510

A small abrupt movement in *H* at 17h. 16m. on March 23 might be taken as the beginning of this storm, which at first did not, however, increase rapidly. The aurora borealis was seen in Britain on each of the above nights. At 17h. on March 23, a biggish group of sunspots was nearly 50° east or four days before central meridian passage of the sun's disk—not a favourable position for any transient corpuscular stream ejected from the spot region to encounter the earth.

On March 28, another disturbance began suddenly at 6h. 35m. and rose to one of great intensity within a few hours. The range in *D* probably exceeded 2¼° and that in *H* 1500 γ, but further details are awaited. The last storm of similar intensity occurred in 1941 on March 1–2, in which the *D* range at Abinger was 3·0°: 1770γ in *H* and > 800γ in *V*. At 6h. on March 28, the spot group was 13° or 1 day past the central meridian. The connexion between the spot region and this storm seems more probable, but at present there is an absence of reports of major solar flares having been observed with their accompanying radio fade-outs. Superficially, the recent solar conditions seem to contrast sharply with those preceding the magnetic storm of February 7–8 (see *Nature*, February 16, p. 187). There was then the great spot near the central meridian; numerous fade-outs had been recorded, and some distinctive solar flares had been observed.

Development of Atomic Energy in Great Britain

SPEAKING in the House of Commons on March 28 on the motion for the adjournment, Mr. John Wilmot, Minister of Supply and Aircraft Production, emphasized a point which has repeatedly been made by scientific men, namely, that there is no justification for the suggestion that the use of atomic energy for peaceful purposes will provide a quick solution of industrial problems. The most probable use will be for the production of electrical power by big units employing steam or gas turbines. The possibilities of development, however, are immense, and Mr. Wilmot considers that the prospects for Great Britain in this connexion are bright. He admitted that the United States has valuable technical experience of which Britain is not fully informed; but experience is being gained through development work now proceeding and mainly financed by the Canadian Government. So far as Great Britain is concerned, he said that the Government is determined to push on with research and development with the utmost vigour; the central planning is in the hands of the Prime Minister and Cabinet, advised by the committee under the chairmanship of Sir John Anderson on atomic energy.

Turning to the work being done in Great Britain, Mr. Wilmot said that the work of converting the airfield at Harwell into the research establishment for atomic energy is proceeding. A team of experts is in Canada preparing plans for the highly specialized buildings required. The planning of the main production plant for fissile material is under way; and engineering and other expert staff is being recruited. No decision has yet been made on a site for the main production plant; a Government factory at Springfields, near Preston, will be used for a subsidiary plant for processing materials. The Government's policy, he said, is also to encourage and support research at the universities and elsewhere on fundamental problems in the field of atomic physics. Speaking of the amount the Government is prepared to spend on this field, Mr. Wilmot said that the limit of what can be done is physical and not financial. It is hoped to mobilize the best brains for the tasks ahead; and as large a sector of the national effort as can be spared will be used for this development, which the Government regards as of transcendent importance.

Biological Risks of Atomic Fission

SIR HENRY DALE, chairman of the Medical Research Council's Committee on the medical and biological applications of nuclear physics, has commented (*Lancet*, 399, March 16, 1946) on the letters written to the *Lancet* by Dr. Wiesner and Mr. Kenneth Walker on the biological dangers of atomic fission (see *Nature*, Feb. 23, p. 222). The issues raised by these letters are, Sir Henry Dale agrees, undoubtedly important; "but," he continues, "having knowledge of what has been done to deal with them, I can say with assurance that all the dangers mentioned in the two letters have received full consideration by those in charge of the Canadian and British Atomic Energy Projects, in connexion with which an elaborate health organisation has been built up". The possibility of genetic effects is being kept in mind and "authoritative opinion is being kept in touch with the nature of the risks to which workers concerned with an atomic energy installation might be exposed, and will require to be satisfied that these are reduced to a level which is not significant. . . ." New information hitherto covered by security restrictions will be released as soon as possible. "A study of the extensive existing literature on this subject," concludes Sir Henry, "would make possible a more correct assessment of the dangers involved than that which the letters of Dr. Wiesner and Mr. Walker might be taken to suggest." Meanwhile some work on the toxicity of uranium is the subject of an annotation in the *British Medical Journal* (397, March 16, 1946). Fair-

hall (*Physiol. Rev.*, 25, 182; 1945) has reviewed the inorganic industrial risks and says that uranium salts are very toxic and may cause chronic nephritis and degeneration of the liver. Gustafson, Koletsky and Free (*Arch. Intern. Med.*, 74, 416; 1944) reported severe tubular necrosis of the kidneys in dogs to which uranyl nitrate had been given intravenously, but sodium citrate, given either by the mouth or intravenously, protected the kidney against uranium poisoning. This was confirmed by other American workers. The reason why sodium citrate should protect the kidney in this way is apparently not known.

Bureau of Current Affairs

THE functions of the new Bureau of Current Affairs which has recently been set up by the Carnegie United Kingdom Trust has been outlined in the first of a series of information leaflets which the Bureau proposes to issue. The leaflet contains a brief summary of the policy of the Bureau and a prospectus of the activities which, gradually, it intends to develop. Although the Bureau does not seek to establish discussion groups, it proposes to act as a 'provisioning' body for those that already exist and those new ones which will be developed by various educational and social organisations. Of the services which the Bureau will offer there will be, first, a discussion-brief in pamphlet form called *Current Affairs*. This will be issued fortnightly and will be similar in size, style and purpose to the Army Bureau of Current Affairs bulletins so long familiar to the Services. The bulk of the twenty-page pamphlet will contain a popular exposition of some selected theme by an accepted authority; the preamble will be a 'layout for discussion' built up in the editorial office. The bulletin will, moreover, be illustrated in a variety of ways—with line-drawings, for example, which the group-leader could reproduce on his blackboard, or with pictorial devices to illuminate some obscure point in the text. The second publication to be launched in the Bureau's immediate programme is a pictorial one called *Map Review*. This, too, will be published once a fortnight and will be produced in poster size and in colour. Its front side will embody in maps, pictures and diagrams the more significant events in current affairs for the particular fortnight, while its reverse side will carry full-scale maps delineating the major political, social and economic problems of our time. Displayed on the walls of any canteen, library or club, these map-reviews will provide a graphic summary of topical issues. The Bureau will also develop other pictorial media. *Current Affairs* and *Map Review* will probably first appear this month.

The war-time promotion of discussion groups has shown the necessity to give group leaders some basic training in the art of chairmanship. In the Services, particularly, many thousands of men and women, in short courses, have been taught the rudiments of discussion group leadership. These concentrated courses produced impressive results, and the Bureau proposes to organise courses on similar lines; a leaflet about them will appear in due course. Besides reference facilities at its London headquarters, the Bureau proposes to have a team of resident advisers to give callers guidance and direction in problems likely to harass the amateur leader of a discussion group. Travelling advisers will carry out similar functions throughout the country. The management of the Bureau's affairs has been initially assigned by the Carnegie United Kingdom Trust to a provisional committee made up partly from the Trustees and partly from people of standing in British education. The chairman is Mr. P. R. Morris, vice-chancellor of the University of Bristol, and the members include Mr. E. Salter Davies, Sir George Dyson, Lord Elgin, Mrs. Walter Elliott, Mr. W. O. Lester Smith, Mrs. Barbara Wootton, Sir Robert Wood and Mr. J. Wilkie. The director of the Bureau is Mr. W. E. Williams, who created the Army Bureau of Current Affairs in 1941 and remained its only director until 1946. Anyone interested in this significant new experiment in adult education may obtain further particulars from the Director at 117 Piccadilly, London, W.1.

Road Research Board

THE Lord President of the Council announced in the House of Commons on April 1 that the Road Research Board of the Department of Scientific and Industrial Research has been re-constituted under the chairmanship of Sir Frank Smith, and that the terms of reference of the Board have been extended to enable it to deal more specifically with problems of road safety and traffic flow as well as with problems of road construction and maintenance. The change is to meet the relevant recommendations of the report of the Select Committee of the House of Lords on the Prevention of Road Accidents (the Alness Committee). The constitution of the Board is as follows: Sir Frank Smith (*chairman*), former secretary of the Department of Scientific and Industrial Research; Major H. E. Aldington, chief engineer (roads), Ministry of Transport; Prof. J. D. Bernal, professor of physics at Birkbeck College, University of London; Mr. J. L. Beckett, city surveyor, Leicester; Mr. R. V. Birch, on the board of several road transport companies; Mr. E. J. Buckton, consulting engineer of Rendel, Palmer and Tritton, consulting chartered civil engineers; Sir George Burt, engineer and contractor, John Mowlem and Co. Ltd., chairman of the Building Research Board, D.S.I.R.; Prof. J. H. Jones, professor of economics, University of Leeds; Mr. E. J. Powell, county surveyor, Glamorgan; Mr. J. Davidson Pratt, director and secretary, Association of British Chemical Manufacturers, chairman of the Road Tar Research Committee, D.S.I.R.; Mr. J. H. M. Richards, borough engineer, Hornsey; Mr. E. C. Ruffle, of Morris Commercial Cars Ltd.; Sir Alker Tripp, assistant commissioner of the Metropolitan Police; Col. T. U. Wilson, county surveyor, Lanarkshire. Assessors have also been appointed to the Board to represent the Ministry of Transport and other Government departments concerned with the work of the Board. The Board is charged with recommending a programme of research, advising on its execution and reporting each year on the work done. The Department of Scientific and Industrial Research will be responsible for conducting the researches.

Veterinary Education in Great Britain

IT was stated in the House of Commons on April 1 that the Government welcomes, in principle, the recommendations made by the Loveday Committee on Veterinary Education in Great Britain and by the Chancellor Committee on Veterinary Practice by Unregistered Persons, and it is intended as soon as practicable to introduce legislation to authorize a university to confer degrees which shall entitle the holders to registration with the Royal College of

Veterinary Surgeons as veterinary surgeons. The Council of the College will also be reconstituted. The Loveday Committee also recommended greatly improved veterinary educational facilities, involving considerable capital expenditure and additional annual expenditure. The Government will be prepared to provide substantially increased financial assistance to veterinary education.

Gift to University of Birmingham

Sir Fitzroy and Lady Anstruther Gough Calthorpe have again shown their practical interest in the University of Birmingham by presenting seven acres of land opposite the northern end of the University Avenue, a position which makes it particularly valuable as a site for the vice-chancellor's house and other amenities which have long been felt to be desirable. It may be recalled that the University stands on land given by the Calthorpe family in 1900, and since then the family has presented sixty-one acres. When the lay-out of the proposed new buildings was being considered recently, it became evident that the existing land, extensive though it be, is not altogether adequate to meet all demands likely to be made upon it. The new gift is therefore specially welcome.

School on Education for Family Life

THE British Social Hygiene Council, in collaboration with the Association for Education in Citizenship, and the Marriage Guidance Council, is organising a week-end school, the first of its kind to be held in Britain, to take place in Morley College, 61 Westminster Bridge Road, London, S.E.1. It is designed primarily to meet the needs of teachers and youth leaders; parents, social workers and others interested will be welcome. The following have promised to speak: Mr. Cyril Bibby, Dr. McAlister Brew, Mrs. E. Hubback, Dr. Housden, Dr. David Mace, Mrs. Mace, Mr. R. Weatherall and Dr. Taylor (governor of Holloway Prison). The fee will be 10s. inclusive. Application for tickets should be made to the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1, from which further details can be obtained.

Institution of Electrical Engineers: Scholarships for 1946

THE Council of the Institution of Electrical Engineers will this year consider the award of the following scholarships, subject to the regulations laid down by the Ministry of Labour and National Service regarding the candidates' ages at the commencement of their courses.

Research Scholarships: Ferranti Scholarship (£250 a year for two years), Oliver Lodge Scholarship (£250 for one year), Swan Memorial Scholarship (£120 for one year), C. P. Sparks War Thanksgiving Fund (not exceeding £100 a year).

Student Scholarships: Duddell Scholarship (£150 a year for three years), William Beedie Esson Scholarship (£120 a year for two years), Silvanus Thompson Scholarship (£100 a year, plus tuition fees, for two years), Salomons Scholarship (£100 for one year), David Hughes Scholarship (£100 for one year), Thorrowgood Scholarship (£25 a year for two years). The closing date for receiving applications is April 15 for student scholarships and June 1 for research scholarships.

Announcements

PROF. H. MUNRO FOX, chairman of the British National Committee for Biology, is on a tour of Europe in order to discuss with colleagues on the Continent co-operation in biological science and particularly the future of the International Union for Biology. After five days in Holland he will proceed to Denmark, Norway, Sweden, Czechoslovakia, Switzerland, France and Belgium in that order, where he will visit the national academy of each country and exchange views with the members. It is hoped that he will also have an opportunity of discussing the needs for scientific instruments and equipment in the laboratories abroad which have suffered from Nazi occupation.

Mr. C. M. WHITTAKER, a director of Courtaulds Ltd. and author of "Dyeing with Coal Tar Dyestuffs", has been elected president of the Society of Dyers and Colourists.

PROF. ALFRED PHILIPPSON, the doyen of German geographers, who returned to Bonn from internment in Theresin last August, has been given the honorary degree of D.Sc. by the University of Bonn.

A SPECIAL meeting of the Royal Anthropological Institute will be held on April 16 in honour of the visit to London of members of the permanent council of the International Congress of Anthropological and Ethnological Sciences. The Huxley Memorial Lecture (postponed from 1941) will be delivered by Prof. Henri Breuil, who will speak on "La Découverte de l'Antiquité de l'Homme et quelques unes de ses evidences".

A JOINT meeting of the Royal Meteorological Society and the Physical Society will be held at the Royal Institution, Albemarle Street, London, W.1, on April 8, beginning at 2.15, for a conference on "Meteorological Factors in Radio Wave Propagation". Nine papers on theoretical and practical aspects of the subject are to be read and discussed.

A GENERAL discussion on "Transformer Oil", arranged by the Institute of Petroleum, will be held at the Institution of Electrical Engineers on April 9, beginning at 3 p.m., under the chairmanship of Mr. E. A. Evans, of Messrs. C. C. Wakefield and Co., Ltd., vice-president of the Institute. Both the petroleum industry and the electrical industry will be represented, so that matters of common interest may be discussed.

A GENERAL discussion on "Dielectrics" has been arranged by the Faraday Society and will be held in the Department of Physics of the University of Bristol during April 24–26. Workers from the United States, France and Holland are to take part in the meeting.

PROF. F. J. COLE writes: "In my review published in *Nature* of March 2, p. 246, of Dr. G. Leboucq's handbook on Vesalius, I concluded from the wording of the imprint that it was a propaganda publication of the Belgian Government. The publishers now inform me that the series which includes the work in question is a private undertaking, and has no connexion whatever with the Government. If I may correct another error in this review, the date 1538 in the first paragraph should be 1533."

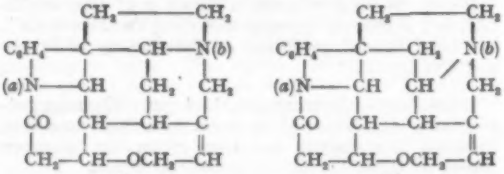
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Constitution of Strychnine and the Biogenetic Relationship of Strychnine and Quinine

In 1942 we considered the possibility that strychnine has the constitution shown in (I), but were unable to find satisfactory explanations of all the transformation products on this basis. This difficulty is no longer insuperable, and in the light of new data and a critical review we now believe that the structure interprets the whole behaviour of strychnine better than any other.

The proposed modification is derived from the current formula (II) (the skeleton of which is now assumed to be contained in dihydrostrychnidine-*D*) by moving N(*b*) from union with a carbon atom of the carbazole ring so that it becomes joined to an adjacent carbon atom. This small change affects a part of the molecule for the structure of which there was hitherto little direct evidence.



(I) (II)

The alternative constitutions of brucine, the colubrines, and the numerous degradation products are obtained by corresponding appropriate modifications (II to I).

The expression (I) contains carbazole, tryptamine and *β*-collidine nuclei. It thus accommodates the formation of these substances in the decomposition of methylstrychnine, strychninolone, etc., by alkaline reagents under rather severe conditions. (II) could yield carbazole and tryptamine but has no ready-made *β*-collidine skeleton; this could only be provided by an intramolecular change.

Prelog and Szpilfogel[1] have suggested a different formula which contains two of the three skeletons. This is unacceptable[2] chiefly because it fails to illustrate the properties of pseudo-strychnine (hydroxystrychnine)[3].

A very significant feature of the new formula is that it has a close relation to that of cinchonine (or *β*-colubrine with that of quinine). The skeletons may be dissected as follows:

Cinchonine Strychnine

The carbon chains indicated are straight; C_4 being probably originally glucose, C_3 a triose; while N.C_3.N and N.C_4.N are regarded as derived from *proto*-lysine and *proto*-ornithine respectively.

One possible interpretation of the C_4 chains was given in 1917[4] and the main lines of that theory stand, though the hypothesis advanced for the $C_4{-}N{-}C_4$ moiety was speculative and is no longer advocated.

An account of new experimental work and a fuller discussion will be published elsewhere, as the matter is too complex for useful summarization.

H. T. Openshaw.
R. Robinson.

Universities of Manchester and Oxford.
March 12.

[1] Prelog and Szpilfogel, *Experientia*, **1**, 197 (1945).
[2] Robinson, R., *Experientia*, **2**, 28 (1946).
[3] Warnat, K., *Helv. Chim. Acta*, **14**, 997 (1931). Blount, B. K., and Robinson, R., *J. Chem. Soc.*, 2305 (1932); 595 (1934). Leuchs, H., *Ber. deut. chem. Gesell.*, **70**, 1543 (1937), and later papers.
[4] Robinson, R., *J. Chem. Soc.*, **111**, 885 (1917).

Isolation of Pregnane-3(*α*)-ol-20-one from the Hydrolysis Products of 'Sodium Pregnanediol Glucuronidate'

Astwood and Jones[1], and Talbot *et al.*[2], have shown that not more than about 70 per cent of the theoretical amount of pregnanediol can be obtained from sodium pregnanediol glucuronidate after hydrolysis with hydrochloric acid. Using a colorimetric method of determining pregnanediol involving the development of a yellow colour on treatment with concentrated sulphuric acid, which is essentially similar to the method employed by Talbot *et al.*, we have confirmed this finding. In the belief that the low yield of pregnanediol obtainable from the glucuronide was due to partial destruction in side-reactions during the hydrolysis, we decided to attempt the isolation and identification of the destruction products.

0·8 gm. of sodium pregnanediol glucuronidate (m.p. 270° uncorr., 280° corr.), prepared from human pregnancy urine, was heated to boiling for 15 minutes with two litres of water and 200 c.c. of concentrated hydrochloric acid in the presence of toluene. The toluene-soluble material obtained from the hydrolysis mixture was separated into two fractions, one soluble and the other insoluble in cold *n*-hexane, and the former (0·1 gm.) after solution in hexane-benzene was adsorbed on an aluminium oxide column. By fractional elution with benzene a main fraction was obtained which after several crystallizations from *n*-hexane yielded a crystalline product, m.p. 149–150° and $[\alpha]_D^{15} = +109°$. This substance gave analytical figures closely agreeing with those required for a compound of the formula $C_{21}H_{34}O_2$, and in the Zimmermann test it gave a brick-red colour quite unlike the pink given by 17-ketosteroids. An acetate and a semicarbazone were obtained from the substance. As the data summarized below clearly show, its identity with pregnane-3(*α*)-ol-20-one cannot be in doubt.

	Substance isolated	Authentic pregnane-3(*α*)-ol-20-one	Mixture
Hydroxy-ketone	m.p. 149–150°; $[\alpha]_D$ + 109°	m.p. 147–149°; $[\alpha]_D$ + 107°	m.p. 147°–149°
Acetate	m.p. 98–99°	m.p. 98–100·5°	m.p. 98–100·5°
Semi-carba-zone	m.p. 246–249° (slight decomp.)	m.p. 248–251° (slight decomp.)	m.p. 248–251° (slight decomp.)

(All melting points are corrected.)

Since it seemed unlikely that the pregnanolone could be formed from pregnanediol during acid hydrolysis, we considered the possibility that the original 'sodium pregnanediol glucuronidate' might have contained a water-soluble derivative of pregnane-3(*α*)-ol-20-one as an impurity. That this explanation is almost certainly the correct one was shown by the fact that six different preparations of sodium pregnanediol glucuronidate, all of which had been carefully purified, were found to give positive Zimmermann reactions with a brick-red tint on 4–5 mgm. quantities.

The usual methods for purifying sodium pregnanediol glucuronidate seem to be ineffective in removing this pregnanolone derivative, since the intensity of the Zimmermann reaction given by one preparation was not noticeably diminished even after two crystallizations from 90 per cent ethanol and two precipitations from aqueous acetone by acetone. Furthermore, a fractionation with Girard's reagent *T* of the toluene-soluble material obtained from this sample after acid hydrolysis showed that about 20 per cent was ketonic. Our findings therefore suggest that 'sodium pregnanediol glucuronidate' prepared from human pregnancy urine and purified by the usual methods may contain as much as about 20 per cent of a water-soluble derivative—presumably the sodium salt of the glucuronide, of pregnane-3(*α*)-ol-20-one. It is possible that sodium pregnanediol glucuronidate has not so far been obtained by anyone free from this contaminant.

We have found that pregnane-3(*α*)-ol-20-one, in the quantities likely to be present, is completely eliminated by the water-ethanol precipitation process employed by Astwood and Jones and by Talbot *et al.* in their methods for determining pregnanediol. We have, furthermore, found that it is only feebly chromogenic in the sulphuric acid reaction. These facts lead us to suggest that the low yields of pregnanediol obtained from 'sodium pregnanediol glucuronidate' after acid hydrolysis by these workers and by ourselves may be partly accounted for by the presence as an impurity in the latter substance of sodium pregnane-3(*α*)-ol-20-one glucuronidate. We would not suggest, however, that destruction of pregnanediol during acid hydrolysis of the glucuronide does not occur at all.

Full experimental details of this work will be published elsewhere.

G. F. Marrian.
Nancy Gough.

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Jan. 22.

[1] Astwood, E. B., and Jones, G. E. S., *J. Biol. Chem.*, **137**, 397 (1941).
[2] Talbot, N. B., Berman, R. A., Maclachlan, E. A., and Wolfe, J. K., *J. Clin. Endocrin.*, **1**, 668 (1941).

Reactions of Organic Halides in Solution

Reactions of organic halides in solution which involve substitution by a nucleophilic reagent at a saturated carbon atom have been extensively studied by Hughes, Ingold and co-workers[1]. These authors conclude that reactions of this type may occur by two possible mechanisms, a unimolecular mechanism S_{N1} or a bimolecular mechanism S_{N2}. The increase in the unimolecular S_{N1} reaction-rate of the halide $R{-}X$ as R varies along the series methyl, ethyl, *sec.*-propyl, *tert.*-butyl, is attributed by these authors to the increase in electron accession to the reaction centre[2]. The decrease in the bimolecular S_{N2} reaction-rate along this series[3] is also attributed to the increase in electron accession to the reaction centre; this electron accession is assumed to inhibit the approach of the nucleophilic reagent.

We have calculated the activation energies of the reactions of $R{-}X$ for the series methyl, ethyl, *sec.*-propyl, *tert.*-butyl, and conclude that the experimental results for the S_{N1} reactions can be satisfactorily interpreted in terms of the quantities (*a*) carbon-halogen bond strength, (*b*) ionization potential of the radical R and the electron affinity of the halogen X, (*c*) heats of solution of the ions R^+ and X^-; and that the results for the S_{N1} reactions can be interpreted in terms of (*a*) carbon-halogen bond strength, and (*d*) steric hindrance.

The unimolecular S_{N1} reaction has been discussed previously for aqueous solutions in terms of the quantities (*a*), (*b*) and (*c*)[4,5]. From a more detailed examination of these quantities, we find that along the sequence MeX to *tert.*-BuX the decrease in carbon-halogen bond strength is of the same order as the decrease in the heat of solution

of the ion R^+. The great increase in the ease of ionization of $R-X$ along this series is found to be due to the very marked decrease in the ionization potential of the radical R from methyl to *tert.*-butyl. The values of the ionization potentials of methyl and ethyl have been determined as 232 and 200 kcal. respectively[4]. The ionization potentials of the *sec.*-propyl and *tert.*-butyl radicals can be estimated from the results of electron impact experiments on *n*-propane, *n*-butane, *iso*-butane, *n*-propyl chloride and *tert.*-butyl chloride[7] as about 179 and 165 kcal. respectively. This decrease of about 70 kcal. in the ionization potential of the radical R from methyl to *tert.*-butyl is the main cause of the increase in the unimolecular reaction-rate of $R-X$ along this series.

The decrease in the bimolecular S_N2 reaction-rate as $R-X$ changes from a primary to a tertiary halide has been attributed by Polanyi and co-workers to the increase in steric hindrance along this series[8,4]. Calculations of this steric hindrance have been made for the methyl to the *tert.*-butyl series[9], and it has been found possible to account for the decrease in the bimolecular rate from MeX to *tert.*-BuX in terms of carbon-halogen bond-strengths and steric hindrance.

Strong evidence for the view that the decrease in the bimolecular rate from primary to tertiary halides is due to an increase in steric hindrance and not due to an increase in electron accession to the reactive carbon atom may be obtained by considering the reactions of allyl chloride and its α- and γ-methyl derivatives. It is found that the unimolecular rate sequence of these chlorides is γ-methylallyl $\simeq$ α-methylallyl > allyl[10]. The equivalence of the unimolecular reaction-rates of the γ-methylallyl chloride and α-methylallyl chloride would indicate that the electron-releasing capacity of the methyl group is transmitted with undiminished power to the seat of substitution[10]. The methyl group, therefore, should cause the same increase in electron accession to the reaction centre, whether it is in the α- or the γ-position, and thus on the Hughes and Ingold theory one would expect the bimolecular S_N2 reactions of these two halides to show the same rate. The observed bimolecular rate sequence, however, is γ-methylallyl > allyl > α-methylallyl[10]. (Rate sequences similar to those given by Hughes have been obtained for the unimolecular and bimolecular reactions of α-methylallyl and γ-methylallyl chlorides by Young and Andrews[11].) This bimolecular rate-sequence is in contradiction to that which would be expected on the Hughes and Ingold theory, and the only factor that can account for this marked difference between the unimolecular and the bimolecular rate sequences of these three halides is the steric hindrance caused by the substituent methyl group. This steric hindrance is present in the bimolecular S_N2 reaction of α-methylallyl chloride but is absent both in the bimolecular S_N2 reaction of γ-methylallyl chloride and in the unimolecular S_N1 reactions of α- and γ-methylallyl chlorides. This is strong evidence for the conclusion that the decrease in the bimolecular reaction-rate as the reactive carbon atom changes from primary to secondary is due to an increase in steric hindrance, as suggested by Polanyi and co-workers, and not due to an increase in electron accession to the reactive carbon atom as postulated by Hughes and Ingold.

The bimolecular S_N2 reaction-rate of $R-X$ decreases as R changes along the series ethyl, *n*-propyl, iso-butyl, neopentyl[10]. Hughes has estimated the steric effect for this series of R and concludes that it may in principle enter in at all stages of β-substitution, but that it assumes real importance only in the case of the neopentyl halides[10]. We have estimated the steric hindrance for this series, and we attribute the decrease in rate of the bimolecular reaction along the whole of this series to the increase in steric hindrance as in the case of the methyl to *tert.*-butyl series.

ALWYN G. EVANS.

Chemistry Department,
University of Manchester.
Dec. 10.

[1] Ingold and Rothstein, *J. Chem. Soc.*, 1217 (1928). Hughes, Ingold and Patel, *J. Chem. Soc.*, 526 (1933). For further references see "General Discussion on Mechanism of Organic Reactions in Liquid Systems", *Trans. Farad. Soc.*, 37, 601 (1941).
[2] Bateman and Hughes, *J. Chem. Soc.*, 945 (1940).
[3] Bateman, Cooper, Hughes and Ingold, *J. Chem. Soc.*, 925 (1940).
[4] Ogg and Polanyi, *Trans. Farad. Soc.*, 31, 604 (1935).
[5] Baughan, Evans, M. G., and Polanyi, *Trans. Farad. Soc.*, 37, 377 (1941).
[6] Hippie and Stevenson, *Phys. Rev.*, 63, 121 (1943).
[7] Hippie and Stevenson, *J. Amer. Chem. Soc.*, 64, 1590, 2766, 2769 (1942).
[8] Meer and Polanyi, *Z. phys. Chem.*, B, 19, 164 (1932).
[9] Evans, A. G., and Polanyi, *Nature*, 149, 608 (1942).
[10] Hughes, *Trans. Farad. Soc.*, 37, 603 (1941).
[11] Young and Andrews, *J. Amer. Chem. Soc.*, 66, 421 (1944).

An Isomeride of Abietic Acid

DURING the course of a series of oil investigations, an oil loaded with resin was distilled *in vacuo* (28 in. mercury): subsequent to distillation the residue was found to contain a substance having the chemical properties of abietic acid but which differed physically in spite of the fact that the nature of the resin present suggested abietic acid. The different physical properties were discovered after purification.

The compound in question is moderately soluble in alcohol and crystallized from such solution in the form of plates having a hexagonal periphery. The molecular weight was found to be 412 and it was easy to prepare retine from it by the normal reduction method. The physical characteristics contrasted with normal abietic acid are:

	Normal abietic acid	New compound
Melting point	159/161° C.	193/195° C.
$(\alpha)_D$	−77	−72

As in the case of normal abietic acid, it was easy to prepare a sodium salt from the new compound; circumstances prevented a check being made to ascertain whether the salts of the normal and new acids possessed similar properties, but further work on this point is in hand.

It should be noticed that the fixed constants of this isomeride differed from those of the isomerides produced by heating abietic acid with acetic acid and hydrochloric acid.

A more detailed account is to be published shortly; in the meantime, I should be very pleased if anyone interested in terpene chemistry who has found similar reactions would take up the matter with me.

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[1] Steele, *J. Amer. Chem. Soc.*, 1333 (1922); 1935 (1934).

Quinoxaline and its Monohydrate

ALTHOUGH quinoxaline, $C_8H_6N_2$, was synthesized in 1884[1,2], and has been mentioned in the literature[1-12] several times since that date, it is rather surprising that the existence of quinoxaline monohydrate has not been noticed, the more so since several physico-chemical determinations have been carried out with quinoxaline; namely, vapour density in diphenylamine vapour[3]; density and refractive indices measured at 48°[4]; depression of the freezing point in diphenyl[5] and use of quinoxaline as the cryoscopic solvent for the molecular weight estimation of naphthalene[6].

Recorded values for the melting point of quinoxaline have varied from 27°[1] to 32·0° (corr.)[5]. It has now been found that quinoxaline as obtained by crystallization from light petroleum (b.p. 40–60°) or by distillation (b.p. 227–229°) is the anhydrous form with m.p. 28° (found: C, 74·1; H, 4·6; N, 21·4; calc. for $C_8H_6N_2$: C, 73·8; H, 4·6; N, 21·5 per cent). On exposure to air the anhydrous quinoxaline is converted within a short time, depending on the humidity, into quinoxaline monohydrate with m.p. 37° (found: C, 65·4; H, 5·4; N, 18·8; $C_8H_6N_2.H_2O$ requires C, 64·9; H, 5·4; N, 18·9 per cent).

Occasionally the anhydrous quinoxaline is precipitated from light petroleum as an oil, but this readily solidifies on the addition of a few drops of water to give quinoxaline monohydrate, m.p. 37°. The existence of the monohydrate is further proved by its behaviour on distillation, when water (identified by its b.p. 100°, and ability to turn anhydrous copper sulphate blue) distils over first, followed by the anhydrous quinoxaline, b.p. 227–229° and m.p. 28°.

A further property of quinoxaline which has escaped mention in the literature is that of its volatility both in air at room temperature and in the vapours of organic solvents at their boiling point; for example, 0·4 gm. quinoxaline distils over per litre of benzene. The quinoxaline can be removed from the distillate and identified as the hydrochloride, and can be detected by the yellow colour given with a drop of concentrated sulphuric acid or by the yellow precipitate given with a benzene or petroleum solution of 2:4-dinitro phenol.

In contrast to the interaction of quinoxaline and potassamide in liquid ammonia to give the dipotassium salt of fluorubin[2], quinoxaline reacts with sodamide in dimethyl aniline at 210–225° to give two products: 2:2'-diquinoxalyl, m.p. 274–276° (found C, 74·4; H, 3·9; N, 21·6; calc. for $C_{16}H_{10}N_4$: C, 74·4; H, 3·9; N, 21·7 per cent. Maurer and Boettger[13] obtained 2:2'-diquinoxalyl from *o*-phenylene diamine and dihydro quinoxalyl glycolaldehyde and give m.p. 274°), and 2:3-dihydroxyquinoxaline, m.p. 386–390° decomp. (found: C, 60·6; H, 3·7; N, 17·8; calc. for $C_8H_6N_2O_2$: C, 59·3; H, 3·7; N, 17·3 per cent. Motylewski[14] gives m.p. 410° for 2:3-dihydroxyquinoxaline obtained by oxidation of 1:2-dihydro-3-hydroxyquinoxaline). The identity of the 2:3-dihydroxyquinoxaline was also confirmed by its conversion to 2:3-dichloro quinoxaline, m.p. 147° (Hinsberg and Pollak[15] give m.p. 150°).

B. C. PLATT.

Wellcome Laboratories of Tropical Medicine,
London, N.W.1. Dec. 20.

[1] Hinsberg, O., *Ber. deut. chem. Ges.*, 17, 320 (1884); *Ann.*, 237, 334 (1887).
[2] Koerner, W., *Acc. dei Lincei, Trans.*, 8, 219 (1884).
[3] Mers, V., and Ris, C., *Ber. deut. chem. Ges.*, 20, 1194 (1887).
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[9] Bergstrom, F. W., and Ogg, jun., R. A., *J. Amer. Chem. Soc.*, 53, 246 (1931).
[10] Kuhn, R., and Bär, F., *Ber. deut. chem. Ges.*, 67, 903 (1934).
[11] Maurer, K., Schiedt, B., and Schroeter, H., *Ber. deut. chem. Ges.*, 68, 1721 (1935).
[12] Sausville, J. W., and Spoerri, P. E., *J. Amer. Chem. Soc.*, 63, 3153 (1941).
[13] Billman, J. H., and Rendall, J. L., *J. Amer. Chem. Soc.*, 66, 541 (1944).
[14] Hinsberg, O., and Pollak, J., *Ber. deut. chem. Ges.*, 29, 784 (1896).
[15] Motylewski, S., *Ber. deut. chem. Ges.*, 41, 804 (1908).
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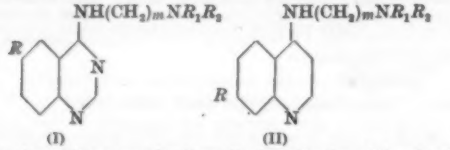
Antimalarial Action of Cinnoline Derivatives

A NOTEWORTHY feature of the published synthetic work relevant to the chemotherapy of malaria is the extent to which attention has been concentrated on the preparation of active agents derived from either quinoline or acridine, of which the two outstanding examples are, respectively, pamaquin and mepacrine. By comparison, little information is available concerning the effectiveness of other structural types, with the important exception of paludrine, the discovery of which was announced recently[1].

In an attempt to discover antimalarial activity in the quinazoline field, various 4-basicalkylaminoquinazolines (formula I; $R = NO_2$ or Cl) were prepared by Magidson and Golovchinskaya[2], but the compounds were stated to be devoid of such activity. Activity is,

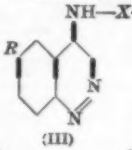
however, exhibited by certain 6-substituted 4-basicalkylaminoquinolines[2], and the closely analogous 7-substituted derivatives (formula II), according to the patent literature[4], are also active.



(I) (II)

In view of these considerations, the investigation of the cinnoline ring-system from the antimalarial point of view is of interest, on account of the close formal similarity which it bears to the quinoline and quinazoline prototypes; and preliminary results indicate that activity may be expected in suitably substituted compounds of this group.

The following substances of general formula III, prepared by us in the course of work carried out in the University of Durham (Durham Division), have been tested against *Plasmodium gallinaceum* in chicks by the technique described by Curd, Davey and Rose[5].



(III)

Compound	Dose (mgm./kgm.)	Activity
(*a*) R = H; X = CH(Me)$(CH_2)_3$. M.p. 103° (found: C, 71·35; H, 8·95; N, 19·5. $C_{17}H_{32}N_4$ requires C, 71·3; H, 9·15; N, 19·55 per cent); di-hydrochloride, m.p. 132° (found: C, 51·55; H, 8·2; N, 14·1; Cl, 18·45. $C_{17}H_{32}N_4$, 2HCl, $2H_2O$ requires C, 51·6; H, 8·15; N, 14·2; Cl, 18·0 per cent).	250 120	Marked Slight
(*b*) R = OMe; X = CH(Me)$(CH_2)_3$. M.p. 160° (found: C, 67·9; H, 8·45; N, 18·2. $C_{18}H_{32}ON_4$ requires C, 68·3; H, 8·9; N, 17·7 per cent).	80	None
(*c*) R = H; X = $(CH_2)_5$. M.p. 145° (found: C, 68·8; H, 8·45; N, 22·05. $C_{16}H_{30}N_4$ requires C, 68·8; H, 8·2; N, 22·95 per cent); dihydrochloride, m.p. 246° (found: C, 47·8; H, 7·5; N, 16·3; Cl, 20·55. $C_{16}H_{30}N_4$, 2HCl, $2H_2O$ requires C, 47·6; H, 7·4; N, 15·85; Cl, 20·1 per cent).	200 120	Doubtful None

The biological tests were carried out in the Blackley Laboratories of Imperial Chemical Industries, Ltd., and we are indebted to I.C.I., Ltd., for permission to publish the findings.

A further point of interest in connexion with these results is that they lend support to the hypothesis of Schönhofer[6] that antimalarial activity is related to the formal possibility of prototropy between the 'normal' molecule (amino-aromatic) and the imino-quinonoid form.

An extended investigation based on these preliminary results is now in progress.

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Liverpool School of Tropical Medicine.

K. Schofield.

Department of Chemistry,
University College,
Exeter. Dec. 22.

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Antimalarial Activity and Toxicity of a Metabolic Derivative of Quinine

The preparation and properties of a metabolic product of quinine has previously been described[1,2], but the results of the studies on the toxicity and antimalarial activity of this compound were not released for publication at that time.

Recently, Marshall[3] has reported that a similarly prepared degradation product does not reduce the peripheral parasitemia of *Plasmodium gallinaceum* in chicks and he concludes that "after the administration of quinine in malaria treatment, a proportion of the alkaloid is converted by the liver of the host into an inactive metabolite".

In our experience, the metabolic product of quinine is suppressive when given intravenously to chicks infected with *P. gallinaceum* in doses of 40–70 mgm./kgm./day (six birds). The degree of suppression is about equal to that obtained in our routine screening test with 15 mgm./kgm./day of quinine. The $L.D._{50}$ of this substance, given intravenously to week-old chicks, is 100–120 mgm./kgm., while that of quinine is 30–40 mgm./kgm. Thus it can be seen that its chemotherapeutic index is of the same order of magnitude as that of quinine.

When the metabolic derivative of quinine is added to the diet of ducks infected with *P. lophurae*, it shows a definite antimalarial activity; but it is less than 1/20 that of quinine[4].

Its suppressive action on the respiration of chicken red blood cells parasitized with *P. gallinaceum* is almost as effective as quinine, but it is less effective in repressing both aerobic and anaerobic glycolysis[5].

These results do not support Marshall's view that the metabolism of quinine results in an inherently less efficient drug, since the reduction in activity and toxicity may well be a matter of decreased penetration into the cell. Therefore, derivatives of quinine (or other quinoline compounds similarly metabolized) with substitutions in the 2-position designed to block the oxidation may prove to be even more effective than quinine itself.

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Synthetic Liquid Penicillin Medium with Glycerine as the Sole Source of Carbon Atom

Penicillin was first obtained from nutrient broth medium by Sir Alexander Fleming. For systematic investigation of this important antibacterial substance, modified Czapek–Dox medium, with glucose as the sole source of carbon, was used by Clutterbuck, Lovell and Raistrick in 1932. Since then, various modifications of Czapek–Dox medium have been tried either to enhance the growth of the mould or to increase the yield of penicillin. But in all these modifications, either sugar or carbohydrate has been chosen as the principal source of carbon. In our experiments with different synthetic liquid media for producing penicillin, we have observed that glycerine can effectively replace either sugar or carbohydrate, hitherto exclusively employed in the liquid media. This observation has an important bearing on commercial production, as glycerine is much cheaper than either glucose or lactose; if it could be suitably adopted for large-scale manufacture, it would eventually reduce considerably the cost of penicillin.

Media used	No. of days of incubation	*p*H	Anti-bacterial titre
2% v./v. Glycerine medium (*A*)	4	6·1	40
	5	6·4	100
	6	6·2	150
	7	6·4	200
	8	6·4	100
4% v./v. Glycerine medium (*A*)	4	6·1	40
	5	6·1	100
	6	6·1	150
	7	6·2	200
	8	6·0	350

We believe we are the first to record a basic change in the source of carbon in synthetic liquid media for penicillin production.

The following glycerine medium (*A*) was used in all our experiments: sodium nitrate, 3·0 gm.; potassium chloride, 0·5 gm.; magnesium sulphate ($MgSO_4.7H_2O$), 0·5 gm.; ferrous sulphate ($FeSO_4.7H_2O$), 0·01 gm.; potassium dihydrogen phosphate, 1 gm.; 'Bacto-Peptone', 10 gm.; glycerine, 20 c.c. or 40 c.c., according as 2 per cent or 4 per cent v./v. was desired; distilled water to make 1 litre. Very satisfactory results were obtained if, instead of distilled water, 1,000 c.c. extract derived from 100 gm. of wheat-bran were employed. 200 c.c. of this medium was used for each sowing bottle.

The organism used was a culture of *Pen. notatum*, G.C. 419 supplied by Dr. B. Mundkar, from the collection of the Imperial Agricultural Research Institute, Delhi. Antibacterial activity was recorded in duplicate in standard nutrient broth medium with Oxford *A. Staph. aureus* strain, in the usual manner.

Further, it has also been noticed that increasing the concentration of glycerine to more than 4 per cent v./v. in the medium does not increase the antibacterial titre.

Detailed work in this connexion will be published later.

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Toadstools and Mushrooms as a Source of Antibacterial Substances Active Against *Mycobacterium phlei* and *Bact. typhosum*

In a survey of more than two hundred kinds of mushroom and toadstool collected in South Australia, antibacterial activity was detected in several members of *Cortinarius* and in one member of *Psalliota*. The tests were made by the cylinder plate method of Heatley[1], with watery extracts obtained by grinding up the mushroom or toadstool in a mortar with a little water. All the active extracts inhibited the growth of *Staph. aureus*, but extracts of only two fungi showed wider activity. *Cortinarius rotundisporus* and *Psalliota xanthoderma* produced extracts which inhibited not only the Gram-positive organism, *Staph. aureus*, but also the Gram-negative organism, *Bact. typhosum*, and the acid-fast organism, *Myco. phlei*.

The crude extracts from *Cortinarius rotundisporus* showed greater activity against the staphylococcus than against *Bact. typhosum*; but the extracts from *Psalliota xanthoderma* showed approximately equal activity against these two bacteria. Against *Myco. phlei* the activity of all extracts was less than that against *Staph. aureus*, but nevertheless was well marked.

It is probable that the substance responsible for the antibacterial activity is different in each fungus, as the crude extracts of *Psalliota* were more readily inactivated by heat and alkalinity than were the crude extracts of *Cortinarius*. Further work on these antibacterial substances is proceeding and will be reported elsewhere.

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Inhibition of *Mycobacterium tuberculosis* by Garlic Extract

Of late there has been an intense search for antibacterial substances effective against acid-fast bacteria, particularly *Mycobacterium tuberculosis*. Apart from the chemotherapeutic work on sulphones and related compounds, a number of antibiotics of fungal origin have been reported[2–7]. However, antibacterials from the higher plants do not appear to have been tested against *Mycobacterium tuberculosis*.

Garlic is one of the well-known remedies for tuberculosis, according to the indigenous Ayurvedic and Unani systems of medicine. In continuation of our work on the chemistry of garlic[8–10], we prepared an antibiotic extract from *Allium sativum*, Linn., by a slight modification of the method of Cavallito and co-workers[11], who found it to be effective against Gram-positive and Gram-negative organisms. However, they did not extend their work to acid-fast bacteria.

In our experiments, *Mycobacterium tuberculosis* (human strain *B* 52, H_{37}, Kasauli) was employed by us as test organism for *in vitro* and *in vivo* studies. In the first group of experiments, flasks containing Long's medium (with ammonium malate instead of asparagine) with the extract in the form of emulsion so as to give concentrations of 2 mgm., 6 mgm., 12 mgm. and 18 mgm. per 100 c.c. of the media were inoculated with two loopfuls of *Mycobacterium tuberculosis* from a slant culture and incubated. No growth was observed after three weeks in any of the flasks containing the extract, while in the control the bacillus grew profusely. In the flasks containing 2 mgm. garlic extract per c.c., slight curdy submerged growth was observed from the fourth week onwards; but it was very slight and slow. This was confirmed by repeated experiments.

We then inoculated 17 c.c. of Long's malate media containing 6·5 mgm. of extract per c.c. in the form of emulsion with three loopfuls of the bacillus from a slant culture and incubated it for 24 hours with a control, similarly prepared but without the extract. Subcultures were made from the two samples on Dorset's egg media, and 2 c.c. portions were injected subcutaneously in the groin region into guinea pigs. After four weeks, no growth was observed in the subcultures from the tube containing garlic extract, while there was good growth in sub-cultures from the control tube. The animals are under observation at present.

In the light of the above observations, garlic extract *in vitro* is bacteriostatic in low concentration and probably bactericidal in higher concentrations. Experiments are now in progress to test the efficacy of the extract in guinea pigs immediately after infection.

Our thanks are due to Prof. V. Subrahmanyan, Drs. N. N. De and K. P. Menon for their interest in our work. We are also grateful to the Council of Scientific and Industrial Research, Delhi, under the auspices of which the work is being done.

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Bronchial Asthma Caused by the Trickling Sewage Filter Fly (*Psychoda*): Inhalant Insect Allergy

Allergic sensitivity to the emanations of various insects (mayfly, caddis fly, moths and butterflies, etc.) have been reported. The trickling sewage filter fly (*Psychoda* spp.) can now be added to the list of such insects causing inhalant bronchial asthma.

Thirteen cases (two Europeans and eleven Africans) of bronchial asthma of varying degrees of severity were investigated at a sewage works in the Transvaal. In all these, the condition was characteristically present in the warmer months of the year and the symptoms occurred during work in the vicinity of the sewage trickling-filter beds where masses of *Psychoda alternata*, Say, accumulate in the shady parts of the grounds and in the neighbouring buildings. The African patients, in addition, developed attacks at night in their nearby compounds, which were heavily infested with the flies. All the subjects claimed to be symptom-free when on vacation or away from the sewage works.

The *Psychoda alternata* is present in great abundance in many sewage works of the Transvaal where the trickling-filter is used for sewage purification. They are plentiful throughout the summer until May, when the first frosts appear. At that time *Psychoda severini*, Tonn., becomes more prominent, although occurring in relatively small numbers, which rapidly diminish with the approach of the warm weather in September.

In view of the striking correlation of the asthmatic symptoms with contact with the *Psychoda*, allergic investigations were carried out on the employees.

The first European case seen was especially closely studied. He had no family history of allergy and, by skin tests, was not found sensitive to any of the commoner inhalant substances (animal dander, feathers, dusts, etc.) nor to a large variety of South African pollens. He gave strongly positive skin reactions, however, to extracts prepared from the *Psychoda*. Passive transfer tests (Prausnitz–Kustner) with the patient's serum were positive. Skin tests gave negative results with extracts of *Psychoda* larvæ and with the hairs of the fly obtained as siftings by gentle agitation of the *Psychoda* in a fine sieve.

The inhalant allergen in *Psychoda* sensitivity was demonstrated to be the dust resulting from the disintegration of the bodies of the flies, which readily become friable.

When the insect origin of the patient's condition had been established, a survey was made of the 35 African employees on the sewage works. Eleven of these who were found to be sufferers from asthma were submitted to skin tests with *Psychoda* extracts. Five of the patients gave a strongly positive reaction and, in four instances where the passive transfer test could be carried out, the result was positive in two of the cases. In a control group of twelve non-asthmatic African employees, no significant reactions were obtained with the *Psychoda* extracts.

It is suggested that all allergic respiratory conditions occurring at, or in the neighbourhood of, sewage works should be especially investigated from the point of view of *Psychoda* sensitivity. Apart from the prevention of the fly nuisance, the importance of the control of *Psychoda* breeding in filter beds assumes a new significance.

Desensitization of the European case with *Psychoda* extract has already been commenced, and a survey of other sewage works has been arranged in order to determine the prevalence of allergic conditions due to *Psychoda*.

Details of the cases, the conditions obtaining at local sewage works and a summary of the methods used in the control of *Psychoda* are being published elsewhere.

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Alloxan Diabetes in a Ruminant

In the ruminant, the digestion of cellulose and other related carbohydrates is achieved through the conversion by the symbiotic flora of the paunch to simple fatty acids with the evolution of methane and carbon dioxide. If the fatty acids which are absorbed constitute the animal's main source of energy, it is possible that ruminants have a novel intermediary energy metabolism[1] in which sugar may play a subordinate part. It is well known that the concentration of glucose in the blood of sheep and goats is normally much lower than that of animals which do not ruminate. Furthermore, relatively large quantities of insulin are necessary to reduce the blood sugar concentration of ruminants to the low levels which lead to hypoglycæmic distress[2,3]. Man and the usual experimental animals go into convulsions in such circumstances; sheep do not go into convulsions, they subside into an apathetic condition followed by coma.

The discovery that the intravenous injection of alloxan will bring about a specific necrosis of the β cells of the islet tissue of the pancreas[4], and result in a diabetic condition in the rabbit[5] and in other animals[6], led to the investigation of sheep when subjected to similar treatment.

Experimental studies with six Merino and six Merino-Corriedale ewes indicated that the intravenous injection of 90 mgm. of alloxan per kilo body weight produced typical diabetes mellitus. Marked individual idiosyncrasy, however, was observed: whereas serious liver and kidney damage supervened on the diabetic condition in some of the animals, two were rendered diabetic without extra-pancreatic complications and were maintained in this condition for 47 and 52 days respectively, when they were slaughtered for autopsy.

Study of the glucose concentration in the blood and total ketone and glucose excretion provided ample evidence of the immediate triphasic response and subsequent hyperglycæmia, with glycosuria and ketonuria typical of alloxan diabetes. A sustained hyperglycæmia of 140–200 mgm. glucose per 100 ml. of blood, with an average daily excretion of about 70 gm. of glucose and 10 gm. of total ketone bodies, was observed. The diabetic syndrome could be controlled with insulin injections.

While it proved possible to demonstrate the α and β cells in the pancreatic islets of the guinea pig, the rabbit and the ox by the differential staining technique of Gomori[7], these cells could not be adequately differentiated in the pancreatic tissues of several normal sheep. In consequence, specific necrosis of the β cells could not be satisfactorily demonstrated in these diabetic sheep.

The data, however, prove unequivocally that the disordered intermediary metabolism typical of alloxan diabetes can be induced in a ruminant.

The details of this study will be published elsewhere.

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Aphosphorosis in Cattle in Offaly

THERE is evidence that in certain parts of Ireland a degree of mineral deficiency exists in old pastures, and, from time to time, isolated cases of disorders which respond to supplemental mineral feeding occur. A more pronounced condition of mineral deficiency is now reported from County Offaly. Mr. J. O'Donovan, county instructor in agriculture, and I are investigating the occurrence; and our results to date show that, over considerable stretches, particularly of the semi-moory type in that county, the old pastures supply insufficient phosphorus to meet the needs of the grazing animal.

Cows confined to such pastures develop a disorder known locally as 'bog crook', 'bog lame', 'rheumatism' or 'leg fever', the symptoms of which are pica, hidebound condition, staring coat, dulling of the skin colouring, reduction in milk yield, constipation, reduction in appetite and in body condition, abnormal posture when standing, difficulty in walking, lameness of one or more legs, a groan when moving and a stiffness and crackling in the joints. Temporary sterility usually sets in. Where the disorder persists, deformities manifest themselves in abnormal growth of hooves, swelling of the joints, stiffness of the backbone and neck with characteristic arching of the back and inability to raise the head to normal level. In chronic cases the extreme emaciation gives to affected stock the appearance of piners. In young cattle growth and development are retarded.

Experiments on the feeding of mineral supplements show that in all cases so far investigated—some forty cows have been on test—the deficiency is one of phosphorus, the supplementary feeding of which is as effective as that of a complete mineral mixture. The feeding of sterilized bone flour at the rate of 2 oz. a day, or meat and bone meal (containing 34 per cent of calcium phosphate) at the rate of ¼ lb. a day causes alleviation of the disordered condition within a few weeks, and completely restores affected animals to normal appearance and health and reproductive activity in six to twelve weeks. It is recommended that the sterilized bone flour and meat and bone meal be mixed with salt and with such palatable foods as sugar beet, bran, or oats in order to induce animals to consume them readily.

The incidence of the disorder is worst during the grazing season; but the symptoms are less pronounced when the pasture herbage is supplemented by meals, especially by bran, the efficacy of which is, no doubt, connected with the comparative richness of these foods in phosphorus.

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Molybdenum and Copper Metabolism of Farm Animals

IN a recent communication from Australia by Dick and Bull[1], the view was expressed that "an increase in the molybdenum content of the pasture may possibly explain the seeming anomaly of a copper deficiency in sheep, for example, grazing on pastures which show by ordinary chemical analysis a copper concentration within normal limits". Since the references are to work in Britain in connexion with a disease of lambs known as 'swayback', the following may be of interest.

In 1943 there was a large increase in the incidence of swayback in lamb flocks throughout Scotland, some flock owners observing this condition for the first time in their lambs and others noting a tenfold increase in incidence. Pasture and soil samples were obtained from three different areas of Scotland—Ross-shire, Perthshire and Midlothian—and were analysed spectrographically. Since a copper therapy had been in vogue for several years in cases of 'teart' in cows, known to be associated with a high content of molybdenum in the pasture, determinations of molybdenum in addition to other trace elements were made.

The copper content of the ten samples examined varied from 4·4 to 9·2 p.p.m., while the molybdenum contents varied from 0·34 to 1·20 p.p.m., the respective values being:

Cu (p.p.m.)	8·3	8·9	8·6	7·0	6·6	6·2	4·4	4·6	5·7	9·2
Mo (p.p.m.)	0·95	1·07	0·94	0·44	0·45	0·34	0·60	0·70	1·00	1·20

Thus, while the copper contents cover values which are marginal (less than 5 p.p.m.) to normal as defined by Bennetts and Beck[2], the molybdenum contents are in all instances normal. Where the copper content exceeds 5 p.p.m., it would appear that, if swayback is due to copper deficiency, some other factor must have affected copper metabolism. It is unlikely, however, since its content is within the usual range for pastures on which cases of swayback do not occur, that it is molybdenum which may be causing a conditioned copper deficiency in the lamb.

We feel that the above results should be made public at this stage in our investigations, lest the unsubstantiated suggestion quoted above should lead to the assumption that the primary cause of swayback in Britain is an excess of molybdenum in the herbage.

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Mechanism of the Proteolytic Activity of Malignant Tissue Cells

THE proteolytic activity displayed by malignant tumour cells *in vitro* has often been the main hindrance to cultivating permanent strains of these cells. The liquefaction of the culture medium by the malignant cells, which has attracted much attention, suggested to me years ago[1] that the proteolytic activity of the tumour cells was fully, or in part, responsible for their malignant properties. By the liquefaction the healthy tissue cells in the neighbourhood are deprived of their solid supports, and consequently the way is prepared for further infiltration deep into the normal tissues.

It therefore was important to know more about the mechanism of the sudden liquefaction which takes place in the plasma medium. Several years ago we found[2] that the digestion of the plasma clot occurs in the homologous medium only. So long as the cells digest the medium, it is impossible to measure the rate of growth. In order to compare the growth-rate of Rous chicken sarcoma cells with that of the normal chicken cells, both cell types had to be cultivated under identical conditions, namely, in a heterologous medium—in this case rabbit plasma.

The chicken sarcoma cells were found to grow without liquefaction throughout many passages, in a culture medium composed of rabbit plasma and chick embryo juice. When transferred to a chicken-plasma medium, liquefaction again takes place.

The liquefaction of the medium may be initiated in different ways: (1) by liberation of proteolytic enzymes from the living cells or after autolysis has taken place; (2) in contact with the desmoenzymes on the surface of the cells; (3) by the activity of the enzymes contained in the blood plasma.

The following experimental observations have been made. When fresh chicken serum was added to the rabbit-plasma-medium, digestion of the plasma clot takes place to the same extent as in chicken plasma. If the chicken serum is first heated to 56° for 3–4 hours liquefaction does not take place. This indicates that the proteolytic enzymes in the surrounding medium must play an important part in the process. This was furthermore demonstrated in the following way. When the Rous sarcoma cells were cultivated in rabbit plasma to which rabbit serum, previously shaken with sand for half an hour, was added, digestion took place as readily as in the homologous chicken plasma.

The explanation of this experiment is probably that the proteolytic enzymes present in the rabbit-serum as inactive proenzymes have been activated by the shaking. In other words, the tumour cells and probably more or less all normal tissue cells seem to be able by contact to activate the proteolytic proenzymes in the homologous blood-plasma. Our experiments show that the activation is rather specific.

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Relation of Intracellular Potassium to the Refractory Period of the Frog's Heart

IT has been known for some time that vagus stimulation and acetylcholine decrease the refractory period of the frog's heart so that the muscle may be tetanized[1]. A similar tendency to tetanization has recently been found in normal hearts[2].

During experiments in this laboratory on removal of potassium from the cells of frogs' hearts, it has been found that decrease of intracellular potassium first produces a holding of contraction with slowing of relaxation, followed by decreased contraction and quickening of relaxation[3].

Measurements of refractory period on hearts treated with atropine-ergotoxine showed that it increased in the first phase and decreased to 30 per cent of normal in the second phase. In the second phase, an extra stimulus just outside the refractory period causes a much increased contraction (see record). For this increased contraction two factors are essential: (*a*) reduced refractory period, (*b*) a block (or blocks) the passage of which is facilitated by the first stimulus, so that the excitation due to the second stimulus gets through—whether the block is one of conduction or one between excitation and contraction mechanisms is not yet clear. The facilitation is maximal at the end of the refractory period and falls to a minimum in three seconds,

SECOND PHASE HEART: THREE CONTRACTIONS. FIRST, RHYTHMIC STIMULUS; SECOND, RHYTHMIC STIMULUS PLUS EXTRA STIMULUS 0·3 SEC. LATER; THIRD, RHYTHMIC STIMULUS.

The block is removed in 2–3 minutes by sodium oleate 1 in 10^3 (quicker by adrenaline 1 in 10^5), as shown by gradually increasing contraction height.

The phenomenon is also seen in vagus stimulation and acetylcholine action, where it is abolished by atropine but not by sodium oleate or adrenaline. In normal hearts, it is found in those ligatured at the sino-auricular junction, but only in April–May when the vagus effect is strong. It is abolished by atropine.

It is especially prominent in hearts in the second phase of potassium removal which are flooded with potassium by turning on to Ringer solution. Here the phenomenon gradually disappears with gradually increasing contraction height, evidently by a redistribution of the extra potassium within the cell.

The phenomenon is essentially the same whether produced by flooding of the cell with potassium, or by vagus stimulation. It seems therefore that vagus stimulation causes inhibition by setting free excess potassium at some position in the cell interior, while adrenaline produces its effect by causing a more beneficial distribution of potassium.

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Physiological Activity of a Single Follicle Occurring in an Aberrant Baboon Ovary

THE physiological activity of a single ovarian follicle is difficult to assess because assay of its fluid content does not entirely represent its functional capacity. No account is taken of the hormones within the cells of its wall. In fortuitous circumstances, an aberrant ovary containing but a single large follicle was observed in a baboon from which two complete ovaries, shown by serial section, had been removed in 1940. Subsequent œstrogen experiments, as originally reported[1], showed that a daily dose of 0·04 mgm. of œstradiol benzoate was the minimum capable of producing optimum swelling of the sex skin, previously attained by both ovaries. Although these experiments were continued for two and a half years, after the first year bleeding did not occur following the withdrawal of œstrogen in any dose whatsoever.

After a lapse of two months, the perineum began to rise spontaneously, and levels attained before castration were again reached. At laparotomy, on the ninth day of perineal swelling, but while detumescing, a small nodule 1 cm. in diameter was removed. It was midway between the right cornu of the uterus and the fimbria of the tube on the anterior aspect of the broad ligament. This mass contained but a single follicle with a maximum diameter of 3·2 mm. Histologically, it was surrounded by irregularly distributed patches of theca lutein cells containing moderate amounts of fat. The granulosa cells lining the follicle were degenerating. The connective tissue around the latter contained many bundles of smooth muscle fibres. Endometrium removed at the same time was late proliferative and did not reflect the changes occurring in the granulosa cells.

This case provides the opportunity of recording the existence of a supernumerary ovary in the baboon, the first in our experience of more than sixty animals subjected to laparotomy. Furthermore, the existence of a single follicle in this ovary permits the conclusion that its œstrogenic activity was equivalent to 0·04 mgm. of œstradiol benzoate, the minimal amount which had previously produced normal turgescence.

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[1] Gillman, J., *Endocrin.*, **31**, 172 (1942).

Radioactive Tracers in the Study of Friction and Lubrication

WHEN one metal slides over another, a measure of the amount of metal transferred from one surface to the other will give an indication of the amount of metallic adhesion occurring during sliding. Bowden and Moore[1], using an electrographic analysis method, were able to detect quantities of copper transferred from a slider on to a platinum surface of the order of 10^{-7} gm./mm.^{2}. Using a radioactive flat surface, Sackmann, Burwell and Irvine[2] measured, by means of a Geiger counter, the pick-up on a small spherical slider. More detailed information has been obtained in this laboratory by using a small radioactive slider and obtaining a contact photograph of the resulting track on a flat metal surface by means of a photographic plate placed directly on it.

The friction apparatus of Bowden and Leben[3] was used, and the slider consisted of lead containing a radioactive isotope from spent radon tubes. Experiments were carried out with this slider moving on steel, copper and lead surfaces when clean and when lubricated with 1 per cent stearic acid in paraffin oil. The 'auto-photographs' were obtained with exposures ranging from 24 to 96 hours.

The accompanying reproductions show enlarged prints of these tracks. Fig. 1*a* shows the effect of lead sliding on unlubricated steel. The motion was a series of sticks and slips with a friction coefficient (μ) of 0·40; the sticks and slips can be seen clearly. In Fig. 1*b* the same surfaces are lubricated, and μ has fallen to about 0·10, with

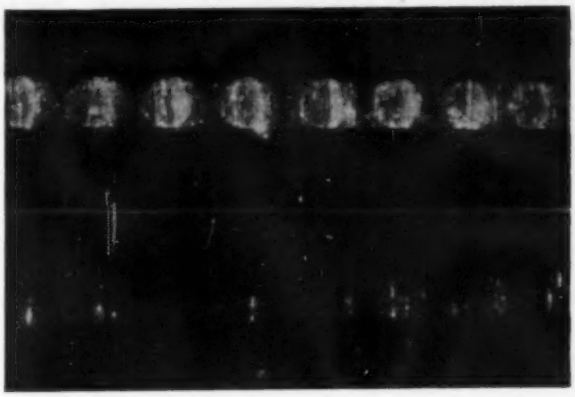

Fig. 1. × 6.

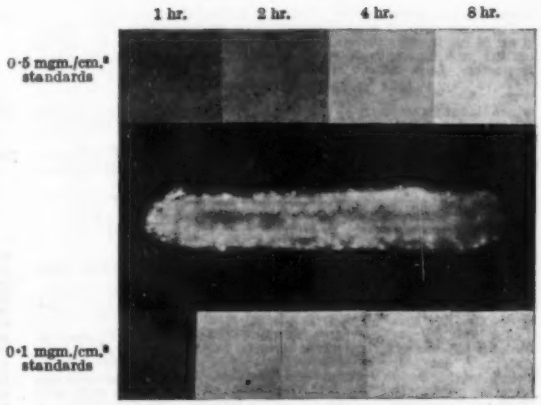

Fig. 2. × 6.

smooth sliding; the decrease in the amount of adhesion and transfer is very marked. Similar results were obtained on copper surfaces.

An attempt was also made to make the method quantitative by measuring the effect on a photographic plate of known surface concentrations of radioactive lead electrodeposited on a platinum surface. It was found that the effect on the plates was approximately linear with time and concentration. (For example, for any given concentration, two plates of, say, one hour's exposure when superimposed gave a darkening, measured visually, equal to that of one plate with two hours' exposure. A similar relationship was found for the effect of concentration.) The track concentration could then be estimated by visual comparison. Results were consistent to within 50 per cent. Fig. 2 shows some standards compared with a track of lead on lead. The lubricant was relatively ineffective, μ being greater than 1·0. The exposure was for 24 hours, and an estimate gives an average track density of about 0·08 mgm./cm.[2]. It is obvious, however, that the film is thicker than this in certain spots.

The accompanying table shows a summary of the quantitative results:

Track	Av. coeff. of friction (μ)	Av. surface density (mgm./cm.[2])	Average film thickness	
			A.	Atoms of lead
Unlubricated lead on steel				
(*a*) Heavy spots on sticks	0·40	0·04	360	120
(*b*) Light parts on sticks		0·010	90	30
(*c*) During the slip		0·005	45	15
Lubricated lead on steel	0·10	0·002	20	6
Unlubricated lead on copper				
(*a*) Heavy spot on sticks	0·33	0·060	550	180
(*b*) Lighter parts on sticks		0·006	60	20
(*c*) During the slip		0·002	20	6
Lubricated lead on copper	0·13	0·005	45	13
Lubricated lead on lead	1·0	0·08	700	230

It is seen that in general the reduction in friction produced by the lubricant is accompanied by a reduction in the amount of metallic transfer. This supports the view that metallic friction is dependent on the amount of adhesion between the surfaces. The role of the lubricant is to reduce the area over which intimate metallic contact occurs.

The radioactive method is particularly valuable in studying the sliding of similar metals where chemical methods of detecting transfer are impossible. It can be made extremely sensitive by using larger concentrations of the active isotope in the slider. So far, only lead has been used, but it is clear that the method can be extended to other radioactive metals. Work is proceeding along these lines.

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Nov. 22.

[1] Bowden and Moore, *Nature*, **155**, 451 (1945).
[2] Sackmann, Burwell and Irvine, *J. App. Phys.*, **15**, 459 (1944).
[3] Bowden and Leben, *Proc. Roy. Soc.*, A, **169**, 371 (1939).

Interferometers and the Group Index

Rayleigh pointed out the importance of the group index in optics more than half a century ago, but the simplifications which the use of a group index G make possible do not appear to have been recognised, though Craven[1] has pointed the way. G is defined as

$$(N + \nu\partial N/\partial\nu),$$

where ν is the wave-number $1/\lambda$ and N is the refractive index.

The range without overlap measured in wave-numbers and written $\Delta_{\nu}\mathcal{E}$ of *all* interferometers is simply $1/L_g$, where L_g is the group optical path difference between successive beams leaving the interferometer. L_g is defined by the equation

$$L_g = Nl + \nu\partial(Nl)/\partial\nu,$$

where l is the geometric path difference. Nl is where the quantity usually known as the optical path difference, which is more strictly the phase-path as opposed to the group-path.

Applied to four interferometers used in the study of hyperfine structure, which are all based on a plate of thickness D, this equation leads at once to well-known equations for the useful range:

Reflexion echelon,	$L_g = 2PD$	$\Delta_{\nu}\mathcal{E} = 1/2PD$
Transmission echelon,	$L_g = (G-1)PD$	$\Delta_{\nu}\mathcal{E} = 1/(G-1)PD$
Fabry-Perot etalon,	$L_g = 2D$	$\Delta_{\nu}\mathcal{E} = 1/2D$]
Lummer plate	$L_g = 2D\,(NG-1)\,(N^2-1)^{-1/2}$	
Diffraction grating,	$L_g = mP\ (\sin I + \sin I')$	

P is here the number of plates, or more strictly the number of interfering beams. In the equation for the grating, m is the order of the spectrum and I and I' the angles of incidence and diffraction.

The formula for the limit of resolution is also valid for a prism. The rays travelling through the vertex and through the base of the prism travel equal phase optical paths, but the rays travelling through the vertex travel in air, so that the path is not a function of λ and we may write it simply ND, where D is the thickness of the base; the optical path through the base varies with wave-length and must be written GD. Thus

$$L_g = (G - N)D = \nu D\ \partial N/\partial\nu,$$

so that the limit of resolution is $\Delta_{\nu}\mathcal{E} = 1/\nu D\ \partial N/\partial\nu$, another well-known result.

The formula here given for the limit of resolution is identical with Ewart Williams's statement[2] that "the resolving power is the path-difference between the extreme beams measured in wave-lengths", if and only if the path is in a non-dispersive medium. Thus Williams's rule leads to the same result as that given above in the reflexion echelon and diffraction grating, but not in the transmission echelon or prism.

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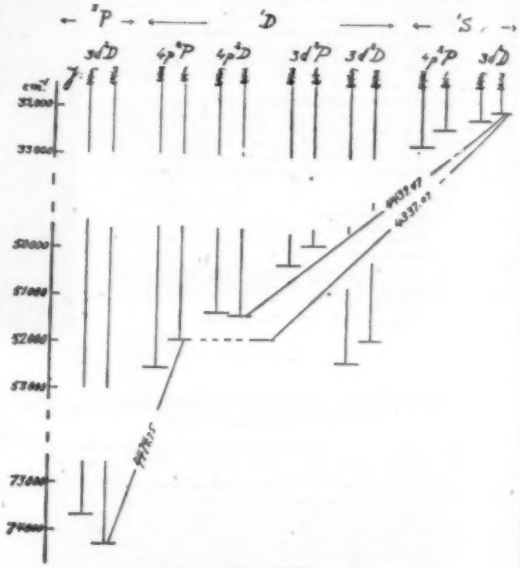
[1] Craven, *Proc. Phys. Soc.*, **57**, 97 (1945).
[2] Williams, W. E., "Interferometry", 27 (1929).

Stark Effect of Spectrum Lines with Predominating Shifts in Final Levels

The displacement of a spectrum line caused by an electric field is composed of the displacements of the initial and the final level. In general, the shifts for a given field-strength increase rapidly with an increasing principal quantum number, and for the non-hydrogenic atoms so far observed the Stark effect in the final level is usually found to be negligible. While investigating the Stark effect of singly ionized argon (Ar II), however, some cases have been observed—as I believe for the first time—where the final levels are shifted much more than the initial ones. An example of this effect will be given here.



Partial level diagram of Ar II.

In the accompanying chart some of the Ar II levels are plotted according to de Bruin's analysis[1]. The term value of $(^2D)4p^2P_{1/2}$ is 51938·2 cm.$^{-1}$ and of $(^1D)3d^2D_{3/2}$ 51924·5 cm.$^{-1}$. According to the perturbation theory applied to the Stark effect, two levels will repel each other if they have opposite parities and $\Delta J = 0$ or ± 1, the repulsion being proportional to the nearness of the levels. Thus, $(^1D)4p^2P_{1/2}$ is pushed strongly downwards by $(^1D)3d^2D_{3/2}$, the level separation being only 13·7 cm.$^{-1}$. The displacement of the level $(^1D)4p^2P_{1/2}$ could be determined from the transition $(^4P)3d^2D_{3/2} - (^1D)4p^2P_{1/2}$, λ 4474·75, as the shift of this line (towards the red) must be entirely due to the displacement of its initial level. Likewise the slight shift of $(^1D)4p^2D_{3/2} - (^1S)3d^2D_{3/2}$, λ 4439·47, must be ascribed to the displacement of its initial level $(^1S)3d^2D_{3/2}$. The transition from the level $(^1S)3d^2D_{3/2}$ to $(^1D)4p^2P_{1/2}$, which are both influenced by the

field, is observed in λ 4337·07. As appears from the accompanying table, the shift of this line (towards the violet) is almost entirely due to the displacement of its final level. The last column of the table shows that the difference between the shifts of λ 4474·75 and λ 4439·47 agrees numerically with the shift of λ 4337·07. The Stark effect of λ 4474·75 and 4337·07 is not fully quadratic for stronger fields as the shift is no longer small (about 2·8 cm.$^{-1}$ for F = 155 kV./cm.) compared with the distance between the levels perturbing each other (13·7 cm.$^{-1}$).

STARK EFFECT SHIFTS IN CERTAIN Ar II LINES

Field strength (kV./cm.)	Displacements in cm.$^{-1}$; minus sign = red shift			
	λ4474·75A.	λ4439·47A.	λ4337·07A.	difference $\Delta\nu$(4439) − $\Delta\nu$(4474)
61·1	−0·59		0·58	0·59
91·2	−1·27	−0·03	1·14	1·24
110·9	−1·68	−0·06	1·58	1·62
132·1	−2·16	−0·13	2·03	2·03
142·6	−2·51	−0·10	2·38	2·41
155·6	−2·81	−0·10	2·56	2·71

The observations were made with a large glass-prism spectrograph adjusted for the spectral range λ 4180–4490, the dispersion being 0·9 A./mm. at λ 4180 and 1·8 A./mm. at λ 4490[3].

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Physical Institute,
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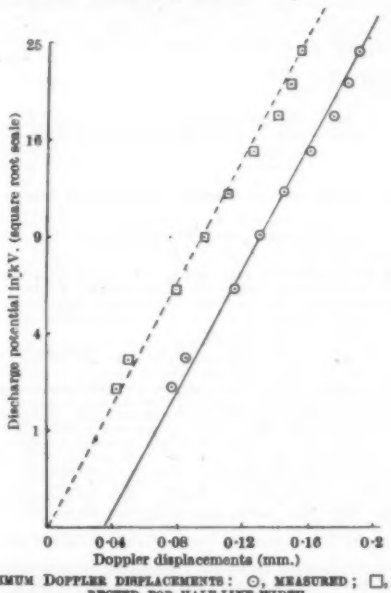
Nov. 20.

[1] de Bruin, T. L., *Z. Phys.*, **61**, 307 (1930).
[2] For further experimental details see Minnhagen, L., "The Stark Effect of certain Multiplets", Dissertation (Lund, 1944)

Role of Line-Width in the Measurement of the Doppler Displacements in Positive Rays

THE Doppler effect in the resonance radiation of mercury λ 2537 A. has been studied by producing a pencil of mercury positive rays by the usual method[1], in a Wine's type of discharge tube. Discharge potentials varying between 2·0 and 24·0 kV. have been used. Maximum Doppler displacement at each discharge potential used was measured from spectra obtained with graded times of exposure. The results are shown in the accompanying graph.



MAXIMUM DOPPLER DISPLACEMENTS: ⊙, MEASURED; □, CORRECTED FOR HALF-LINE-WIDTH.

It can be seen that the maximum Doppler displacements, as actually measured, do not fall on the theoretical line but are displaced, each through a constant value, away from it. They, however, fall on another line drawn parallel to the theoretical line. This constant displacement is equal to about half the mean width of the undisplaced line. The values of the Doppler displacements, corrected by half-line-width, however, fall on the theoretical line drawn for a singly charged mercury atom.

Doppler displacements, in a positive ray beam with a spectrum of velocities, are usually measured from the centre of the undisplaced line up to the edge of the Doppler band. If, however, the positive ray beam were homogeneous, a displaced line would be obtained instead of a band. The maximum displacement will then be the distance from the centre of the undisplaced line to the centre of the displaced line, but not up to the edge of the displaced line away from the undisplaced line. In the case of the Doppler band, however, the measurement extends up to the edge of the band. Thus the maximum displacements so measured will be higher than the actual values by about half the line-width. The correction will be significant only when the displacements are small and are comparable with the line-width. This will be the case in positive rays of heavier atoms like mercury and will be more prominent at low discharge potentials. In hydrogen, this correction has been found to be quite negligible[2].

This correction explains the results of Das[3] obtained in his measurements on λ 4358 A. of mercury. A detailed discussion of these results with reference to the work of Stark and co-workers[4] will be reserved for publication elsewhere. I wish to thank Dr. B. Dasannacharya for his valuable help during the course of this investigation.

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Guntur.
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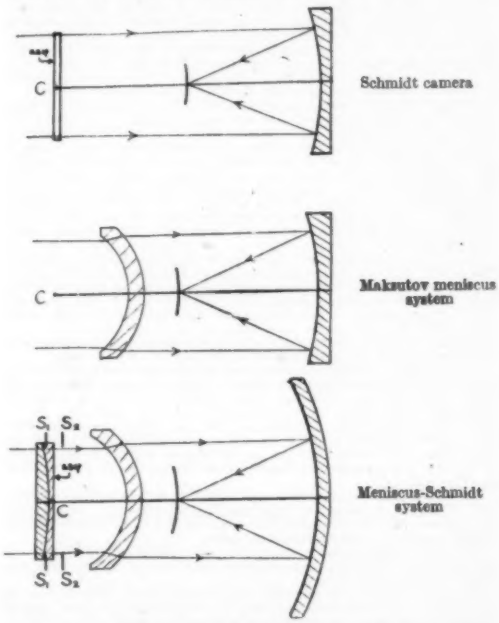
[1] Stark, Herman, and Kinoshita, *Ann. Phys.*, **21**, 462 (1906).
[2] Dasannacharya, B., and Dakshinamurti, C., *Nature*, **154**, 22 (1944).
[3] Das, G. K., doctorate dissertation, Benares Hindu University (1938).
[4] Stark, Wendt, Kirschbaum and Künzer, *Ann. Phys.*, **42**, 241 (1913).

An Improved Type of Schmidt Camera

As has been mentioned in *Nature*[1], D. D. Maksutov has shown that the aspheric plate of an $f/2·5$ or $f/3$ Schmidt camera of aperture[2] not exceeding two or three feet can be replaced by a simple meniscus lens, the spherical surfaces of which are nearly concentric with the mirror surface. Maksutov pointed out that a system with a strictly concentric meniscus is feasible provided that a certain amount of primary chromatism can be tolerated, and that such a system has the valuable property of giving uniform definition throughout its curved field.

It is interesting to consider what results can be obtained by combining in a single system the ideas of Maksutov and of Schmidt. We find that the optical performance which can be reached in this way is much superior both to that of the classical Schmidt camera and to that of the Maksutov meniscus systems with spherical surfaces.

We shall refer to the new system as a meniscus-Schmidt system. Briefly stated, its mode of operation is as follows.



In the classical Schmidt, an aspheric plate located in the aperture-stop at the centre of curvature C of a spherical mirror removes the only Seidel error affecting image quality of the system sphere-plus-stop, namely, primary spherical aberration, at the cost of introducing two fifth-order off-axis aberrations. In the meniscus-Schmidt, we first correct the primary spherical aberration of the mirror by a strictly concentric meniscus, obtaining a three-component system (aperture-stop plus meniscus plus mirror) free both from Seidel errors—field curvature always excepted—and from all fifth-order errors except zonal aberration. If the fifth-order zonal aberration is now corrected

by a weak aspheric plate located in the aperture-stop, the off-axis aberrations introduced by the plate are all of the seventh and higher orders, and so may be expected to be very small.

In the actual design of the system, fuller particulars of which we hope to publish elsewhere, we proceed somewhat differently, choosing the concentric meniscus so as to minimize the on-axis aberrations as a whole, and the aspheric plate to give axial stigmatism. The effect of this procedure is to balance out some of the seventh and higher order off-axis errors by a suitable combination of small amounts of lower order errors.

To correct the colour-error of the meniscus, a doublet plate is used (see diagram), its glasses having the same mean refractive index but different dispersions. The off-axis colour-effects of the plate interface turn out to be harmless.

In this way, an $f/1{\cdot}2$ system is obtained which, working over a 30° diameter field, sends 97 per cent of the light of each image into a confusion circle less than 21″ of arc in angular diameter. The remaining 3 per cent of light has, of course, no appreciable effect on the resolution, but it can be eliminated if desired by adding a pair of extra stops S_1, S_2, equal in aperture to the aspheric surface, at a distance of one tenth of this aperture on either side of it. The result is a system of nominal aperture $f/1{\cdot}2$ and effective aperture $f/1{\cdot}5$, nearly free from edge-vignetting, the error-spreads of which over a 30°-diameter field are less than 21″ of arc, that is to say, only a small fraction of those of the classical Schmidt camera, or of the meniscus system with spherical surfaces.

DOROTHY G. HAWKINS.
E. H. LINFOOT.

The University,
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Nov. 30.

[1] *Nature*, **155**, 798 (1945).
[2] Maksutov, D. D., *J. Opt. Soc. Amer.*, **34**, 270 (1944). Mention should also be made of a system by D. Gabor (Brit. Pat. 544,694; 1940), based on the same idea and employing an annular aperture.

Anti-Reflexion Films Evaporated on Glass

DURING the past decade, much progress has been made on the production, by the evaporation method, of anti-reflexion films on glass surfaces. Up to date, the metallic fluorides have proved the most successful as evaporating materials. Many of these fluorides have been tested, and now magnesium fluoride is probably favoured most.

At first, workers engaged themselves with the proper methods of cleaning the glass surfaces before being placed in the bell jar. Then the subjection of the surfaces to glow discharges, during the evacuation of the bell jar, was examined as a means of completing the cleaning process. When the films were deposited, baking at various temperatures in an air oven was tested, and finally evaporation on to glass surfaces, maintained at high temperatures (200–300° C.), was carried out. Dr. D. A. Lyon, United States Naval Gun Factory, was, I believe, the first to evaporate magnesium fluoride on to hot glass surfaces.

I have carried out research on the production of anti-reflexion films by the evaporation method. In the case of magnesium fluoride, a number of samples have been tested. These samples were prepared in three ways, namely, by the action of hydrofluoric acid on (1) magnesium chloride, (2) magnesium carbonate, (3) magnesium oxide. The samples prepared from magnesium oxide had a considerable amount of magnesium oxide in the final product, but this seemed to affect the films very little. It has been found necessary to dehydrate carefully all magnesium fluoride preparations. It was found that hydrates stored in glass bottles for more than three months gave inferior films.

The method of evaporation involves the use of a molybdenum boat and baffle. The material is preheated until it begins to vaporize freely in the vacuum before the surfaces are coated. During the preheating the baffle protects the surfaces. The tests applied to the films are those recommended in the U.S. Army Specification No. 51–70–4A of January 28, 1944.

A study has been made of the effects of baking in the case of glass coated with magnesium fluoride film. It has been found that:

(*a*) It is most advisable to bake the glass at a temperature of 250° C., approximately, for about thirty minutes in the vacuum before coating. This preheating improves the glass surface by expelling adsorbed gases and vapours and by removing traces of fatty acids, etc. It has been noticed that films deposited on cold glass surfaces, which were first baked and then allowed to cool to room temperature, did not craze when afterwards baked in an air oven at temperatures as high as 375° C. If the glass is not baked before coating, there is a tendency to craze and peel.

(*b*) If the surface is allowed to cool to 200° C. or below before coating, then it will be necessary to bake the film afterwards in an air oven for several hours at a temperature of about 250° C. to render it sufficiently perfect to pass all the above tests.

(*c*) If the surface is maintained at a temperature of 250° C. or more (tested up to 350° C.) during evaporation, then no further baking is required after evaporation.

(*d*) If one quarter wave-length magnesium fluoride films are evaporated on cold glass surfaces, then the reflectances of these coated surfaces are reduced considerably by baking in an air oven at 250° C. for a number of hours. If the surfaces are baked at 375° C. the reductions are greater, especially where the very dense flint glasses are concerned. These reductions range from 20 to 40 per cent. For example, for crown glass ($n = 1{\cdot}52$) the reflectance was reduced, by baking at 375° C., from 1·40 to 1·10 per cent approximately, while for Chance optical glass ($n = 1{\cdot}806$) the reduction was from 0·23 to 0·14 per cent, approximately. These figures correspond to a reduction in the estimated film refractive index of 1·39 to 1·37 in the case of the crown glass, and 1·405 to 1·39 in the case of the flint glass.

As compared with magnesium fluoride films, it has been found that calcium fluoride films react very differently to baking. As in the case of magnesium fluoride, it is advisable to bake the glass to about 250° C. in the vacuum prior to coating. The following reactions have been found:

(*a*) If a crown glass surface is allowed to cool so that it is at a temperature of 100° C. or less during coating, then the resulting film will have a reflectance which gives an estimated refractive index as low as 1·26 approximately. This film is very soft, and, when baked in an air oven at 250–300° C. for several hours, increases slightly in reflectance and hardness.

(*b*) If the surface is at a temperature of 120° C. about, during evaporation, the film has a somewhat larger reflectance. This film is soft.

(*c*) If the surface is at a temperature of 230–250° C. approximately, the resulting film is fairly hard, but will not quite withstand the rubbing test indicated in the U.S. Army specifications.

(*d*) If the surface is at a temperature of 280–300° C., the resulting film is very hard and will withstand all the tests. The estimated refractive index is 1·40 approximately. When the glass surface is at a temperature of 330° C., during evaporation, the reflectance corresponds to a refractive index of 1·42 approximately.

(*e*) When a number of glass surfaces, placed at equal distances from the evaporating boat, and maintained at different temperatures, varying from room temperature up to 350° C., are coated with calcium fluoride, the resulting films have all approximately the same optical thickness.

(*f*) Using iron $K\alpha$ radiation and a special focusing camera, powder photographs of calcium fluoride films, having an optical thickness of $\frac{1}{4}\lambda(5500)$, were obtained. From these photographs it was evident that (1) the films were made up of very small crystals in random orientation, (2) these small crystals had the same cubic structure as the parent substance, (3) the structure and random orientation persisted independently of the temperature or the nature of the glass surface.

It appears, from (*f*) above, that the change in reflectance of the film-coated glass is probably due to a change in density of the films according to one of the mixture rules[1]. It also appears that, according to (*e*) above, the film thickness is inversely proportional to its refractive index.

In the case of magnesium fluoride films, the estimated refractive index increases with the refractive index of the glass. For example, a film deposited on a crown glass surface will have a refractive index of 1·39, whereas the value for a flint glass surface ($n = 1{\cdot}65$) will be about 1·41. This does not occur to any extent in the case of calcium fluoride, and in no case is the estimated refractive index of a calcium fluoride film greater than the refractive index of a single crystal of calcium fluoride.

I have produced very strong films, with an estimated refractive index of 1·35 approximately, by using a mixture of cryolite and calcium fluoride (1 : 1 or 1 : 2 by molecular weight). These films are very much like "gearksutite" films[2], but are more soluble in water. The "gearksutite" films are very satisfactory, but pure anhydrous aluminium fluoride is necessary in their production. This fluoride is difficult to prepare except in very limited quantities.

A more complete account of the investigations on the above-mentioned and other films will be published elsewhere.

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Nov. 27.

[1] Heller, W., *Phys. Rev.*, **68**, 5 (1945).
[2] R.C.A. Commonwealth of Australia Patent No. 7010/42.

Current Density at the Cathode Spot of the Mercury Arc

LAST July, I observed that the cathode 'spot' of the transient arc obtained by discharging a condenser through a vacuum tube with mercury cathode took the form (a few microseconds after initiation) of a number of very small spots. The current density of emission appeared at least 100,000 amp. per sq. cm., however prolonged the discharge and however nearly the characteristics of the discharge approached those of a 'normal' arc. These results were obtained from low-power photomicrographs (up to × 25) using a Kerr cell shutter giving an exposure of one microsecond.

This suggested taking similar photographs of a more normal arc. Recent photographs of the cathode of a 50 amp. and 120 amp. D.C. arc 1/200 sec. after initiation show the cathode spots do in fact still have a similar structure. They show that for the 120 amp. arc there are generally four to eight main groups of about four or five minute spots. The number of groups is smaller for the 50 amp. arc. If the electronic emission comes chiefly from these minute spots, then the current density is nearer 100,000 amp. per sq. cm. than the usually accepted value of about 4,000 amp. per sq. cm.[1–4]. Exposures of 24 microsec. show that the minute spots generally seem to move within the envelope of the group. Hence only the groups might be observed with an ordinary camera. Lord[5] has presumably observed such groups with the Kodak high-speed camera, and states that for a 1,150 amp. arc the cathode spot sometimes divides into 75 parts.

It is hoped to publish a full report of these investigations in due course.

I would like to thank Sir George Thomson for continued encouragement and advice. Since October 1945 I have been working as a Beit Fellow in his Department at the Imperial College of Science and Technology.

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Dec. 6.

[1] Hull, *Elec. Eng.*, **53**, 1435 (1934).
[2] Loeb, "Fundamental Processes of Electrical Discharge in Gases", 629 (John Wiley, 1939).
[3] Smith, *Phys. Rev.*, **62**, 48 (1942).
[4] Teago and Gill, "Mercury Arcs", 12 (Methuen, 1936).
[5] Lord, *Electronics*, 11 (May 1936).

A Definition of Plasticity

THE word 'plasticity', although one which has attained a state almost of ubiquity in several branches of applied physics and industrial chemistry, has, according to Scott Blair[1], never been given a quantitative and dimensional definition. In the technical literature a group of quantitative 'plasticity numbers' have taken their place. Such expressions as the Williams plasticity number, or the Goodrich plasticity number (both used in rubber technology), have no quantitative meaning other than that of the reading of a particular type of testing equipment when used in a particular manner, and as such cannot be expressed in C.G.S. units.

An excellent qualitative definition of plasticity has been given by Wilson[2] and is quoted by Scott Blair. Plasticity is defined as "that property which enables a material to be deformed continuously and permanently without rupture during the application of a force that exceeds the yield value of the material". As it stands, this definition does not permit of a quantitative interpretation, but it is not difficult to make it quantitative.

If we denote the stress acting by τ and the strain produced by σ then we may write generally for the behaviour of a solid

$$\tau = f(\sigma) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The stress is a function only of the strain. For a fluid body generally :

$$\tau = f\left(\frac{d\sigma}{dt}\right) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

For a plastic body :

$$\tau = f\left(\sigma, \frac{d\sigma}{dt}\right)$$

This expression may be perhaps more simply expressed by the fractional differential equation

$$\tau = f\left(\frac{d^{\alpha}\sigma}{dt^{\alpha}}\right) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where the exponent α, which lies between 0 and 1, varies with the magnitude of the stress. The qualitative definition of Wilson above implies that for a plastic body the value of the exponent α changes fairly rapidly from 0 to 1 as the stress passes the yield value. We may therefore define plasticity quantitatively as the reciprocal of the relative stress-change required to change α from zero to unity. As, however, both these limiting values may be approached asymptotically, it might be better to define plasticity as *the reciprocal of twice the relative stress change required to change the exponent* α *from* 1/4 *to* 3/4.

To measure the plasticity of a material in terms of this definition, we divide the material into a number of samples. To each sample a different stress τ is applied and the strain σ measured as a function of the time. Curves of log σ versus log t are then drawn. Up to the yield point, these curves will be straight lines parallel to the log t axis, but at higher stresses positive slopes $\left\{\frac{d \log \sigma}{d \log t}\right\}$ will be obtained.

As both log σ and log t are dimensionless quantities, the slopes will also be dimensionless and the stress required to attain a given value of the slope will have the dimensions $[ML^{-1}T^{-2}]$.

As illustrated by the work of Andrade and Chambers[3], the expression $d \log \sigma/d \log t$ may not always be independent of t (the time elapsing since applying the stress τ). We may, however, characterize each curve of log σ versus log t at constant τ by the fixed initial value of the slope, namely :

$$\left(\frac{d \log \sigma}{d \log t}\right)_0.$$

We next proceed to plot this quantity against the stress τ. Let $\tau_{1/4}$ be the value of τ required to give a slope of 1/4, and let $\tau_{3/4}$ be that required to give a slope of 3/4. We then give as the quantitative definition of plasticity :

$$\text{Plasticity} = \frac{\tau_{3/4} + \tau_{1/4}}{\tau_{3/4} - \tau_{1/4}} \quad . \quad . \quad . \quad (4)$$

In terms of this definition, plasticity becomes a dimensionless quantity having the same magnitude in all units of measurement.

In illustration of the definition given above, a few simple examples will now be considered. In a Bingham system, that is, one for which the rate of flow follows the law ;

$$\frac{d\sigma}{dt} = 0 \qquad \tau < f$$

$$\frac{d\sigma}{dt} = \frac{1}{\eta}(\tau - f) \qquad \tau > f, \ \eta \text{ a constant.}$$

$$\tau_{1/4} = \tau_{3/4} = f$$

and the plasticity in terms of equation (4) is infinite.

In a system which breaks down fairly sharply from that of an elastic solid to one which Reiner[4] would term a St. Venant plastic, $\tau_{1/4}$ and $\tau_{3/4}$ are both finite and $\tau_{3/4}$ is slightly larger than $\tau_{1/4}$. The plasticity of such a system is (by equation 4) a large positive number, being the larger the more rapid the change-over from elastic to plastic behaviour.

For both brittle solids and fluids (either Newtonian or non-Newtonian) $\tau_{1/4}$ and $\tau_{3/4}$ are both purely imaginary and the plasticity as defined by equation (4) is indeterminate.

For systems undergoing crystalline glide with associated shear hardening, the rate of flow $d\sigma/dt$ and constant stress τ decreases with time and ultimately becomes zero. For such systems the value of the exponent α is always less than unity. Should α in addition never attain the value 0·75, $\tau_{3/4} \to \infty$ while $\tau_{1/4}$ remains finite. For such systems the plasticity, according to the definition suggested in this letter, is unity.

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Sept. 17.

[1] Scott Blair, G. W., "A Survey of General and Applied Rheology" (London : Pitman, 1944).
[2] Wilson, H., "Ceramics, Clay Technology" (New York : McGraw-Hill, 1927), 55.
[3] Andrade, E. N. da C., and Chambers, B., *Proc. Roy. Soc.*, A, **138**, 348 (1932).
[4] Reiner, M., *J. Sci. Instruments*, **22**, 127 (1945).

Need for the Development of Tropical Ecological Stations

WE emphatically agree with most of the recent letter from Dr. Chapman and others[1] on the need for the development of tropical ecological studies. Such studies are essential to the work of the practical applied scientist—the agriculturalist or forester—and also in the field of pure ecology. There are, however, a number of points which seem to be wrongly stressed, or left unmentioned. Dr. Chapman *et al.* themselves state that theoretical ecology is to-day to some extent based on unbalanced data, drawn from only a part of the world's vegetation. It is possible that much modification may be necessary to this theory as the details of vegetation in regions with predominantly phanerophytic floras become known.

One point must be questioned. Dr. Chapman and his collaborators state that the tropics require synecology before all else ; and further, that factors other than mere floristics should be regarded as the main "Characters determining the aspect and form of the community".

We submit that for any rational understanding of vegetation—and that is the ecologist's primary concern—full investigation must be made into all the main determinative factors of vegetational distribution and relations. These are species distribution, climate, geology and soils, water relations and drainage, topography and biotic effects. Only when *all* are considered together is there any hope of reaching a true understanding of the vegetation. To decry the first on the grounds that it is 'difficult' is scarcely reasonable.

The real reason why such a course is promulgated is that in most tropical regions, certainly throughout Africa, our present knowledge of the flora is limited. In Europe, with the flora at a high level of taxonomic resolution, ecological studies are possible at any level, and any particular aspect can be stressed. Further taxonomy must go hand-in-hand with ecological studies, and the latter must not be attempted unless accompanied by the former. To suggest that this limiting factor of taxonomic resolution can be by-passed by concentration on other more abstract and intangible criteria is merely to court disaster.

We have recently attempted to carry out synecological work in Nigeria ; in fact, the mandate of duty for one of us is largely in agreement with Dr. Chapman's suggestion that one or more officers should be specifically directed to write up descriptions of various types of vegetation and any ecological conclusions that may emerge. Our progress in these studies has been entirely dependent upon a fuller and more critical taxonomic acquaintance with the West African flora. This applies as much to the wet forest regions as to the drier savannahs. One of us can recall the failure of early attempts to understand dry-zone vegetation, in the light of his university training in ecology. The importance of floristic studies was under-emphasized in this training and not over-emphasized, as the writers of the letter suggest. It was only when the problems of floristics, both distributional and taxonomic, were considered, that any real understanding of the vegetation *in terms of its causal agents* was achieved. We do not, we trust, as former pupils of two of the signatories, lack appreciation of the need for studying other aspects of the vegetation.

In conclusion, may we suggest that, while wholeheartedly supporting the plea for more tropical ecological work under a more widely based and competent directive, there should be, nevertheless, the fullest possible co-operation between the field ecologist and the systematists working on the partially resolved tropical floras.

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[1] See *Nature*, **157**, 377 (1946).

Literature for the Hong Kong Fisheries Research Station

AS a result of Japanese aggression in Hong Kong, the entire library of the Fisheries Research Station and the private libraries of myself and of Mr. S. Y. Lin have been lost. We were particularly unfortunate in that a Japanese bomb completely demolished the field station situated at Aberdeen, Hong Kong, and with it all the specimens and records contained therein ; others housed in the science building at the University were also lost as the building was gutted by fire.

Among records missing is the list of persons and institutions with whom publications were exchanged for the *Hong Kong Naturalist* and *Supplement* and the *Journal of the Hong Kong Fisheries Research Station*. The Fisheries Department, with temporary offices in the G.P.O. Building, Hong Kong, would be grateful if any individuals, or institutions, who would like to make or renew contacts, or to present literature, would write to the officer in charge.

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RESEARCH ITEMS

A New Cephalaspid Fish

T. S. Westoll has described "A New Cephalaspid Fish from the Downtonian of Scotland, with Notes on the Structure and Classification of Ostracoderms" (*Trans. Roy. Soc. Edin.*, **61**, Part 2 (No. 13); 1945). This fish is represented by a single head-shield and by a few separate scales. It is well preserved and is referred to a new genus and species, *Hemiteleaspis heintzi*, belonging to the sub-family Hemicyclaspinæ of Heinz. Interesting notes are given on the Cephalaspid skeleton and the, so-called, electric fields. It is suggested that the 'electric fields' in all probability have no electric organ function but are special sensory organs. With regard to the growth of the skeleton, the author is of the opinion that the cephalaspid bony skeleton is ossified only at full growth. The classification and evolution of Ostracoderms are discussed with special reference to the form of the body based on an analysis of swimming control. The paper is illustrated by diagrams and a photographic plate.

Distribution of Irish Char

Arthur E. J. Went has continued his studies of Irish fishes and now discusses the char, *Salvelinus* spp. (*Proc. Roy. Irish Acad.*, **50**, B, No. 8; Feb. 1945). These are rare fish in Ireland, although their distribution is fairly widespread, mainly in the maritime counties. This account attempts to bring together most of the information on the subject. The author acquired nine specimens of *Salvelinus colii* Gunther from the eel nets of Inishard, Co. Mayo. It appears to be the most widely spread of Irish char and is recorded from nineteen localities. Six Irish species are recognized. Most interesting quotations are included from observations by old naturalists, the earliest reference to char in Ireland being in the Cromwellian "Civil Survey" (1656) for the Barony of Muskerry, in manuscript, later published by the Irish Manuscript Commission (1856).

Adaptation and Heredity

S. Spiegelmann, C. C. Lindegren and G. Lindegren (*Proc. U.S. Nat. Acad. Sci.*, **31**, 95; 1945) have discovered an extremely interesting mechanism of adaptation in yeast. This has far-reaching consequences in considering cell reaction and cytoplasmic units, as emphasized by the work of Sonneborn and Rhoades. The fermentation of the sugar meliobose by yeast is inherited in a ratio of equal numbers of fermenters and non-fermenters in the four haploid segregants of an ascus. When, however, the ascus is in the presence of meliobose, all segregants have the ability to ferment the sugar; and the derived clones can retain this ability indefinitely so long as the sugar is present. If, however, the sugar is removed, only the gene-determined fermenters can re-synthesize the enzymes for fermentation. The enzymes initiated by genes of the genetic fermenters can be propagated in cytoplasm of non-fermenters so long as the substrate is present. It would seem that the gene in this case and possibly others acts as a trigger mechanism.

Quantitative Method of Estimation of Epeirogenic Movements

By postulating the rate of subsidence in geosynclines to be proportional to the thickness of accumulated deposits, A. B. Ronov (*Bull. Acad. Sci. URSS.*, Sér. géog. géophys., No. 6 (1944), No. 2 (1945), English summaries) made an attempt to calculate the rate of epeirogenic movements in the Uralian and Caucasian geosynclines. The average thicknesses of deposits were calculated from the estimated total volumes of sediments deposited during given geological periods. These values, plotted against absolute time, provided curves expressing the rate of subsidence. The rate of elevation was similarly calculated from the average thicknesses of material removed by denudation during given geological periods. The two curves thus obtained provided a rough estimate of the rate of epeirogenic movements during the formation of the geosynclines.

Geology of Macquarie Island

Macquarie Island is the summit, 21 miles long, of a very much longer ridge which extends north and south as a submarine feature situated between Antarctica and the Tasman Sea. During the Australasian Antarctic Expedition of 1911–14, L. R. Blake spent the greater part of two years in making a detailed study of the geography and geology of the island. Unfortunately, Blake was killed in action on the last day of hostilities in 1918. However, his maps, records and collections have been worked up into a fine monograph by Sir Douglas Mawson, who has himself made two short visits to Macquarie (*Sci. Rep. Austral. Antarctic Exped.*, Ser. A, **5**, 194+46 figs.+37 pls. Gov. Printing Office, Sydney, N.S.W., 1943). The earliest rock formations consist of a thick series of basaltic flows and sills and associated greywackes, possibly of Triassic age. These were later folded and invaded by gabbros and peridotite. After a period of erosion the region subsided and received a deposit of globigerina ooze, followed by extensive outpourings of basaltic pillow lavas. During the Pleistocene ice age, Macquarie Island was evidently part of a land of very considerable size, for all that now remains has been severely glaciated by ice that came from an area to the west now occupied by deep sea. Block subsidences have since submerged most of the former land mass, leaving the island as an elongated horst. Recent uplift is indicated by a pronounced wave-cut platform standing at heights up to 40 ft. above sea-level. This feature is now being rapidly consumed by wave erosion.

Stabilization of Ships by Activated Fins

The control of ship oscillations has received much attention, and a satisfactory solution of this problem would be appreciated by many voyagers. In a paper before the Institution of Naval Architects, J. F. Allan shows, however, that the problem concerns not only the comfort of passengers, but also affects the safety of ships in very heavy weather and the gun control of naval craft. Stabilization, in the applications described, is effected by means of fins which project through each side of the vessel below the water-level. These are controllable to allow slight rotation, the period being synchronized so that the righting moment induced by the forward motion of the ship and the angle of the fin counterbalances the tendency to roll induced by the waves. Complete drawings of installations are given, together with test results on models and vessels up to 14,000 tons sea-water displacement. The fins are operated hydraulically and can be withdrawn into the hull when not needed; control is effected by gyroscopic means, and the angle of roll may be reduced to less than 25 per cent of that which would occur without the stabilizing fins.

A Cristobalite Modification of Ice

H. KÖNIG (*Z. Krist.*, **105**, 279; 1944) has reported the result of electron diffraction analysis of the cristobalite modification of ice. He condensed water-vapour on a collodion film cooled with liquid air in an electron-diffraction apparatus (approx. 10^{-4} mm. Hg vacuum). In order to prevent the condensation of impurities (grease, carbon dioxide, etc.) the film was surrounded by a protective chamber the walls of which were colder than the film itself. When the temperature of the film was between − 70° and − 160° C., a thin sheet of ice formed, which gave good electron diffraction transmission patterns, showing fourteen distinct rings. These agreed completely, in position and intensity, with a diamond-like arrangement of oxygen atoms. The ordinary hexagonal form of ice, melting at 0° C., corresponds to the β-tridymite (structure type *C* 10) form of SiO_2. This cubic form of ice, found only below − 70° C., corresponds to the β-cristobalite (*C* 9) form of SiO_2. In each case the oxygen atoms would have four hydrogen atoms tetrahedrally attached, not necessarily, of course, at a uniform distance. The lattice constant of the β-cristobalite ice at about − 100° C. is $6{\cdot}36 \pm 0{\cdot}01$ A. ($O-H\cdots O = 2{\cdot}75_4 \pm 0{\cdot}00_4$ kX.), the density being approximately the same as that of β-tridymite ice at the same temperature. The number of molecules per unit cell for the hexagonal ice is 4, that for the cubic ice is 8. König found that below − 160° C. the cubic ice formed in very small crystallites giving broad rings; above − 160° C. the crystals were larger and the diffraction rings quite sharp; at about − 80° C. the ice partly volatilized and new rings appeared, which corresponded to the usual hexagonal ice form. Above − 70° C. the pattern of both sets of lines disappeared completely (for a poorer vacuum the temperature of evaporation was somewhat higher). No sharp transition point appeared to exist between the cristobalite and tridymite forms. W. Rau (*Schrift. deut. Akad. Luftfahrtforsch.*, **8**, 65; 1944) suggests that this cubic ice modification examined by König is the same as that independently observed by him (see also Frank, F. C., *Nature*, **157**, 267; 1946).

White Dwarf Stars

THE May issue of *Sky and Telescope* contains a short account of Dr. P. L. Bhatnagar's view that rhythmic expansions and contractions may occur in dense stars, even in white dwarfs, just as they do in Cepheid and long-period variables. He believes it is quite natural that a star should be left pulsating after it has collapsed into a white dwarf. In the same issue there is a short account of the views of G. Gamow, of George Washington University, who thinks a white dwarf may be the remains of a former red giant star in which the outer layers have been lost and the white dwarf core exposed. The stable state of a star with a core exceeding 10 per cent of the total mass will consist of three different regions: (1) degenerated nucleus, (2) isothermal layer of ideal gas, and (3) radiative envelope. The conditions at the boundaries between the successive regions determine the size and luminosity of the star. Assuming such a stellar model, the gradual approach of the energy-producing shell to the stellar surface will be accompanied by the ejection of the star's outer layers. The loss of a large part of the stellar mass will lead to the unveiling of the white dwarf, which was gradually developing in the centre of the star during the red giant part of its evolution. Comparisons with data on stars in spiral galaxies lead to the conclusion that the stars in the arms of the spirals are younger than the nuclei of such systems.

Estimation of Arginine

M. Rocha, E. Silva and Sylvia O. Andrade have investigated "The Flavianic Acid Method for Estimation and Extraction of Arginine" (*Rev. Brasil. Biol.*, **4**, No. 1), the object being to examine Vickery's method of arginine estimation and to suggest improved methods. The original Vickery's procedure suffered from the disadvantage that it could be used only when large quantities of fresh tissues were employed, and to obviate this the authors devised a process which is applicable under semi-micro conditions. As their object was to compare results obtained with different tissues rather than to estimate the arginine content of each one separately, this requirement is fulfilled by the flavianic acid method because the arginine content of a few hundred milligrams of a dried protein can be estimated in this way with sufficient accuracy. Although the procedure is not strictly applicable under real micro conditions, such as for estimating the amount of free arginine in tissue deproteinized filtrates, other methods can be used in such cases with great success. It was shown by Sakaguchi in 1925 that when sodium hypochlorite is added to an alkaline solution of arginine in the presence of α-naphthol, a red colour develops. This test was only qualitative, but in 1930 Weber showed that quantitative results could be obtained in this way, and two years later Jorpes and Thorén substituted sodium hypobromite for the sodium hypochlorite originally used by Sakaguchi. Several other methods are described, some of which require a considerable amount of time and careful manipulation; on the whole, the flavianic acid method is considered the most satisfactory, and is applicable with considerable success for semi-micro determinations of arginine (7–8 mgm.).

Biological Properties of Anacardic Acid, Cardol and Derivatives

CASHEW nut oil, the main constituents of which are anacardic acid and cardol, has, apart from its use in the varnish and lacquer industry, been occasionally employed as a skin irritant and for the treatment of leprous lesions. Dr. F. W. Eichbaum, Escola Paulista de Medicina, Sao Paulo-Rua Botucatú, 720, Brazil, has now reported, in a communication to the Editors dated May 30, 1945, which is too long for publication in full, on the biological properties of the lipoid and water-soluble sodium salt of anacardic acid. It is highly surface-active and possesses good emulsifying power. It is bactericidal against all Gram-positive and some Gram-negative bacteria in concentrations of 5×10^{-6} to 5×10^{-7}, but no chemotherapeutic action in infections by such bacteria has yet been observed. Toxins such as *Bothrops* venom and tetanus toxin are destroyed by it *in vitro*, but not *in vivo*, in concentrations of 10^{-3}. It has also promising larvicide, anti-ectoparasitic, antiprotozoal, antifebrile and anti-enzymatic activities. Although it is hæmolytic at 2×10^{-5} (2×10^{-3} in serum), leucocytes suspended in blood plasma are not destroyed by concentrations of 10^{-3}. Subcutaneous injections of 1 per cent solutions produce sterile necrosis, but intact human skin is not irritated by such solutions or by ointments. Very promising results have been obtained in the local treatment of specific and non-specific urethritis, and in local suppurative processes of the skin.

CLOUDS: THEIR CHARACTERISTICS AND FORMATION

AT a 'geophysical discussion' held at the Royal Astronomical Society on February 22, with Sir George Simpson in the chair, the subject was "Clouds".

The discussion was opened by Mr. C. J. P. Cave, who explained that he would illustrate the different types of clouds and then proceeded to show a magnificent series of cloud photographs. Some excellent examples of cirrus were shown, and Mr. Cave directed attention to the frequent occurrence of wisps which were curled upward, and thickened at the end, the direction of the wisps not usually lying along the length of the cloud band. He pointed out that while such formations are frequent in depressions, they may also occur in anticyclones.

He next showed some photographs of cirro-cumulus, in some of which were striking examples of polar bands. Such clouds are to be seen in nearly all parts of the world, and Mr. Cave showed photographs from the British Isles, the West Indies, and elsewhere. There followed some photographs of cumulus, mostly taken in the West Indies, but some examples also from mid-Atlantic and from the British Isles. These photographs generally illustrated the fact that cumulus very frequently tend to occur in long parallel lines, stretching occasionally for hundreds of miles, rather than as single wool-pack clouds with clear spaces between.

A further series of slides illustrated the sharp outline of the head of a rapidly growing cumulus cloud with the development of cirrus at the top and the formation of an anvil. In some of the later photographs of thunder clouds, Mr. Cave directed attention to the formation of stratus ahead of the main mass of cumulus, the stratus showing as a dark line against the bright side of the thunder cloud, and well below the level of the top of the latter. He then showed examples of the mammato-cumulus which occurs frequently at the level of the base of the cumulo-nimbus. He next went on to show examples of alto-cumulus castellatus, and showed how such clouds frequently led to thunder storms.

Mr. Cave ended his series of illustrations of natural clouds by showing first a photograph of altocumulus in the form of irregular and roughly parallel bands, following this by showing a negative print of a photograph of ripples in the sand at Hayling Island, upside down. He then showed the Hayling Island slide turned up the right way, when it became obvious what was the true nature of this photograph. The resemblance between the altocumulus cloud and the picture of sand ripples at Hayling Island when shown upside down was extremely close, and it would not have been difficult to convince oneself that the second photograph also represented a cloud.

Mr. Cave then showed some vapour trails from aircraft, many of them produced at so great a height that the aircraft producing them were invisible. He directed attention to the fact that optical phenomena such as halos and mock suns could be observed in these vapour trails very frequently, and he concluded by showing a slide of a mock sun surrounded by a 46° halo.

The slides which Mr. Cave showed were very much appreciated by his audience, who were particularly pleased by the demonstration of the resemblance between the altocumulus cloud and the ripple formation on the sandy shore.

Mr. D. R. Barber, of the Kodak Company, then demonstrated a film made at the Kodak Laboratories at Rochester, New York, which showed records of the whole sky from dawn to sunset. The recording unit is in two parts: the first a recording photometer consisting of a photo-cell mounted in an opalescent spherical diffuser, the output from which, after amplification, is used to operate a level recorder; the second a convex hemispherical mirror mounted with its axis vertical, having a small circular mirror slightly inclined a few feet above it. The light reflected by the mirror falls on the lens of a cine-camera mounted below and to one side of the hemispherical reflector. With this equipment, in which the camera is a standard Kodak instrument, single frames can be exposed at intervals varying from one second to one minute. When the film is projected at a normal rate, it is possible to show on the screen the changes in sky covering and the nature of cloud taking place in twelve hours within from half an hour to thirty seconds. The equipment was illustrated in the first reel of the film shown by Mr. Barber, and a number of films showing the cloud movement for whole days during the spring and summer of 1944 were shown, ending with a series of photographs taken by the light of a full moon.

The discussion was continued by Prof. D. Brunt. He said that although Mr. Cave's altocumulus photograph resembles in a very striking way the photograph of ripples formed in sand, it is possible that the mechanisms which produced the two were entirely different. He proceeded to illustrate the types of motion produced in unstable air in a small chamber having a metal base which could be heated electrically from below, and having a glass top, the motion of the air being shown by tobacco smoke. When the difference in temperature between the top and bottom of the chamber had passed a limit, which depended on the depth of the chamber, the motion which set in took the form of polygonal cells with descending motion in the centre and ascending motion at the outer margin. This required that the depth of the chamber should be at least 7 mm. With smaller depth it was impossible to form polygonal cells, and the unstable motion took the form of small circular cells with ascent in the middle. With the glass cover of the chamber sufficiently long to be capable of being moved across the top of the chamber, the air within the chamber undergoes a shear and the type of motion produced depends upon the rate of shear. When the shear is extremely small, the polygonal cells are simply distorted slightly in the down-wind direction. With slightly greater shear, the motion is in a series of long rolls transverse to the direction of motion of the top plate. With high rates of shear, the smoke takes the form of long rolls directed longitudinally down wind. All these forms of motion were illustrated by slides showing the actual motion photographed in the laboratory. Prof. Brunt then showed a photograph of altocumulus (due to Mr. Cave) in which there were two sets of rolls or waves at right angles to each other. He next showed a slide illustrating the occurrence of transverse and longitudinal rolls simultaneously in the chamber used in the laboratory, the condition being that the shear should be near the critical limit between the conditions producing transverse and longitudinal rolls. This slide, as was pointed out in showing it, illustrated the possibility of explaining rather complicated cloud forms as due to a combination of instability and shear. With reference to

the formation of a single long roll of cumulus extending a great distance, Prof. Brunt showed a slide in which was depicted the illustration of a cold front with nose elevated above the ground, taken from a paper by the late M. A. Giblett. The ascent of the warm air over the nose of the on-coming wedge of cold air could in certain cases lead to the formation of cumulus at the nose of the wedge, and this explanation of single rolls had in fact been put forward by Mr. Giblett in the paper from which the picture was taken.

Mr. C. S. Durst then described some data which had been prepared by Dr. A. H. Goldie, but who was unable to attend the meeting. It has been shown by Dr. Cwilong at Oxford that in clean air ice crystals will only form when the temperature is between −35° and −45° C. In polluted air ice crystals form at a higher temperature. Dr. Goldie has found that, over Salisbury Plain, cirrus cloud forms in air at temperatures below −25° to −28° C., but over Lerwick similar clouds were not formed until the temperature was below −32° C. It is inferred that the atmosphere over Salisbury Plain, being more polluted than that at Lerwick, accounts for the difference in the conditions in which cirrus clouds form in the two localities.

Mr. A. W. Brewer discussed the question of the formation of vapour trails from aircraft, pointing out that an aircraft engine burns fuel at a very rapid rate, every pound of petrol used yielding about 1·4 lb. of water. The exhaust gases both raise the temperature of air and raise its humidity. Which of the two factors will predominate will depend on the temperature, and Mr. Brewer stated that at ground-level condensation trails will be produced if saturated air below −23° C. is present, while at 20,000 ft. the temperature must be below −43° C. if trails are to form. It is found that in practice the temperature of the air must be about 4° C. lower than those mentioned before trails can form, and Mr. Brewer showed some of the results obtained during flights which confirm this. Persistent trails require a saturated atmosphere, and low temperatures and super-saturation may occur together at the tropopause, thus explaining the frequency of the occurrence of vapour trails at about this level. At a greater height within the stratosphere the humidity falls off rapidly, so an aircraft can avoid making trails by climbing to a high level above the tropopause. Mr. Brewer went on to point out that the persistence of a trail requires super-saturated air. Now super-saturation with respect to water is not found in the atmosphere, though at temperatures below freezing point the air may be super-saturated relative to ice. Thus condensation trails will only persist at temperatures below freezing point.

Prof. G. M. B. Dobson then spoke of the work of Dr. Cwilong and described how this work has shown that at low temperatures, round about −40° C., water vapour condenses directly into ice-crystals without passing through the liquid phase. When air below −40° C. is expanded to about double its original volume, ice crystals can easily be formed, and this is a likely explanation of the formation of cirrus cloud. If water drops are formed at a higher temperature than this, they may persist without freezing down to a temperature as low as −40° C. Thus altocumulus at great heights is not surprising.

Sir George Simpson then directed attention to a paper by Findeisen published shortly before the outbreak of war and dealing with the formation of cumulus. This writer suggested that such clouds grow until their top freezes, giving ice crystals which spread downward until a level is reached where the temperature is 0° C. Sir George pointed out that this would also explain certain measurements of electric fields inside clouds, which he found to descend at about the rate at which he computed the snow would fall.

Mr. D. J. Schove directed attention to the importance of cloud observation as an adjunct to forecasting. He pointed out that when there is a horizontal gradient of temperature in the atmosphere, cumulus clouds take the form of long lines along the isotherms. When there is a horizontal gradient of temperature in the atmosphere, the rate of change of wind with height is a vector directed along the isotherms. The cumulus clouds which form in these circumstances, and to which Mr. Schove directed attention, thus belong to the class of longitudinal rolls mentioned earlier in the discussion.

ECOLOGY OF THE EELWORM CYST

By Dr. C. ELLENBY
King's College, Newcastle-upon-Tyne

WHEN cysts of the potato-root eelworm, *Heterodera rostochiensis* Wollenweber, are stimulated with potato-root excretion, larvæ begin to emerge from the cyst after a delay of some days : the number emerging per day increases steadily, reaches a maximum, and then declines, even though fresh root excretion is continually supplied ; finally larvæ no longer emerge. The reduction in the number of larvæ emerging, per day, is connected, to some extent, with the reduction of the number of embryonated eggs as the experiment proceeds, but its cessation is not due to their exhaustion ; cysts from which larvæ no longer emerge still contain large numbers of eggs, and larvæ will again emerge if the cysts are re-stimulated after an interval. This phenomenon is probably of considerable importance to the eelworm ; all the larvæ contained in a cyst will not emerge in a single season, and the attack on the host plants will tend to be damped. The mechanism by which it is brought about, however, has received little attention. Hitherto it has been thought to be due to some difference in the state of development of the eggs inside the cyst ; but as it is shown by cysts which are some years old, and as an interval of a few weeks between the first and subsequent stimulation is sufficient to cause many more larvæ to emerge, this theory is inadequate. Experiments with punctured cysts now show that such a theory is untenable and that the cessation of emergence is due to factors operating within the cyst *as a unit*.

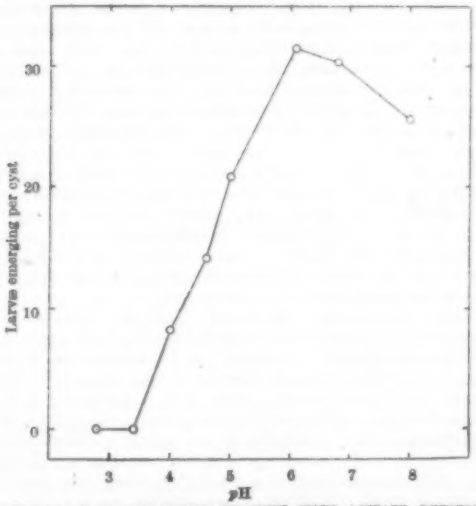
One experiment involved eighteen groups of twenty-five cysts, each treated for other purposes, in a different fashion ; a small hole, however, was made with a needle in five out of each group of twenty-five cysts. All the groups were then stimulated with potato-root excretion in the usual way, using a single cyst technique[1], emerging larvæ being counted until emergence had practically ceased. As the nature of the different treatments is irrelevant from the present point of view, the effect of puncturing, in each group, has been demonstrated by expressing the number of emerging larvæ, per punctured cyst, as a percentage of the emergence per normal cyst ; these results are

TABLE 1.

Emergence of larvæ from punctured cysts as a percentage of the emergence from normal cysts. Each figure is based on the emergence from 5 punctured and 20 normal cysts.		
225	413	196
157	197	188
332	223	163
178	307	87
189	241	132
252	206	167

shown in Table 1. In almost every case, the punctured cysts produce at least twice as many larvæ as the normal cysts. The existence of an additional exit might enable larvæ to emerge more rapidly ; it would scarcely cause larvæ to hatch which were not ready to do so. The only hypothesis adequate to explain these facts seems to be that the cessation of hatching is due to inhibition ; and the simplest explanation would be that the inhibitor is produced as a result of the stimulation of the eggs by potato-root excretion. Presumably, the larvæ inside the eggs are normally in a dormant state ; potato-root excretion causes them to hatch, increases their metabolism, and the increased metabolism leads to the accumulation of an inhibitor within the cyst ; puncturing the cyst permits the substance to escape more rapidly and thus delays the onset of inhibition. Clearly, the eggs constitute an ecological community, and the behaviour of individuals in the community affects the behaviour of the others.

It is tempting to assume, by analogy with the metabolism of other animals, that the inhibitor, if it exists, is an acid ; it is certainly true that pre-treatment of cysts with acid solutions results in reduced larval emergence. In one experiment cysts were soaked for twenty-four hours in a series of acetate buffers ; they were then washed thoroughly, soaked for another twenty-four hours in distilled water, and then stimulated with potato-root excretion in the usual way. (Solutions of root excretion are slightly acid.) The results are shown in the accompanying graph. From *p*H 6·7 to *p*H 4·0, the number



EFFECT OF PRETREATMENT OF CYSTS WITH ACETATE BUFFERS ; ON SUBSEQUENT STIMULATION IN POTATO-ROOT EXCRETION, THE NUMBER OF LARVÆ EMERGING IS SEEN TO BE AFFECTED BY THE NATURE OF THE PRETREATMENT. EACH POINT IS BASED ON THE EMERGENCE FROM 25 CYSTS DURING FIVE WEEKS.

of larvæ emerging decreases steadily ; at *p*H 3·4 and below, there is no emergence at all. The groups of cysts spent twenty-four hours in different buffers, but their subsequent treatment in the five weeks during which larvæ emerged was exactly the same ; nevertheless, the emergence in the groups was very different. The effect of the pre-treatment is therefore remarkably persistent and can scarcely be due to *p*H alone ; but it is an inhibition, rather than a toxic effect, for the feebly hatching cysts were found very productive the following year. Cysts treated with buffers at and below *p*H 3·4, however, failed to produce larvæ the following season, and, presumably, had been killed by the treatment ; mineral acid at these *p*H's is without this toxic effect. These results will have to be considered in more detail in relation to recent findings[5] on the relative toxicity of organic and inorganic acids to the related nematode *Rhabditis* ; it is most interesting, for example, that the isoelectric point of the cuticle is considered to be about *p*H 3·5.

Although increasing acidity has such a marked effect, the graph shows that larval emergence is reduced on the alkaline side too ; it is possible, therefore, that marked disturbance of the *p*H, in either direction, may bring about the cessation of hatching.

The hypothesis here advanced may help also to explain a number of other aspects of eelworm behaviour ; for example, the seasonal hatching rhythm which cysts show, and the fact that cysts which have been soaked for prolonged periods in water produce more larvæ on subsequent stimulation[2].

TABLE 2. EFFECT OF PRETREATMENT OF CYSTS WITH DIGESTIVE ENZYMES. 25 CYSTS IN EACH GROUP.

Pretreatment	Trypsin	Boiled trypsin	'Earthworm juice'	Boiled 'earthworm juice'
Larvæ emerging, per cyst	53·60	23·12	51·08	21·40

The increased emergence from punctured cysts is very similar to the increase in the emergence from cysts which have passed through the gut of earthworms[3] ; since reporting this observation, I have shown that the influence of earthworms is due, in part at least, to the effect of digestive enzymes. Cysts pretreated with trypsin or pepsin solutions at room temperature for twenty-four hours produce many more larvæ than controls treated with the boiled solutions ; moreover, the same effect is produced by juice removed, by a recently described technique[4], directly from the gut of starved earthworms. The results for this experiment are shown in Table 2 in a comparison with a trypsin solution ; while the very close agreement of the results is no doubt a coincidence, it is clear that digestive enzymes have a marked effect and that the effect of the two preparations is similar. There is some evidence that the cyst wall is affected by the enzyme ; but it may also act on the egg-shell, the larva, or even on material between the eggs. Any of these actions could lead to changes in the rate of diffusion and might therefore account for the similarity of the effect of digestive enzymes and puncturing of the cyst wall.

[1] Ellenby, C., *Nature*, **152**, 133 (1943).
[2] Boyd, A. E. W., *Ann. Appl. Biol.*, **30**, 161 (1943).
[3] Ellenby, C., *Ann. Appl. Biol.*, **31**, 332 (1944).
[4] Millott, N., *Proc. Roy. Soc.*, B, **131**, 271 (1943).
[5] Stephenson, W *Parasitology*, **36** 158 (1945).

CHEMICAL NATURE OF SALTS FROM BONES AND TEETH AND OF TRICALCIUM PHOSPHATE PRECIPITATES

By Dr. H. BRASSEUR, Dr. M. J. DALLEMAGNE and Dr. J. MELON
University of Liège

ACCORDING to recent papers[1], it seems that much confusion still prevails concerning the physical and chemical properties of tricalcium phosphates. Experimental researches, performed during the War, enabled us, however, to elucidate many difficulties in this field and to demonstrate our misinterpretation of many previous experimental results. Our researches originally dealt particularly with the molecular nature of salts from bone and teeth, but were later extended to the nature of tricalcium phosphate precipitates.

(1) It is generally believed that bone salts are constituted either of hydroxylapatite which has adsorbed calcium carbonate or of carbonato-apatite, because bone salts give the same powder diffraction photograph as apatites. We have shown that in fact bone salts diffract X-rays similarly to the apatites because they are mainly made of a salt 'isomorphous' to apatites, namely, α tricalcium phosphate, in a merely physical association with carbonate. The main arguments in favour of our views are as follow :

(*a*) If we submit bone to the fractional solubility method, we observe that small quantities of acid in contact with bone salts first dissolve only calcium carbonate, but no phosphorus. It is thus possible, with accurate quantities of citric acid, to separate chemically the carbonate of bone from the phosphate without destroying the latter. Hence, bone salts are a simple physical complex of phosphate and carbonate. If we were dealing with carbonato-apatite, the two constituents of the compound could not possibly be separated by using the same chemical method.

(*b*) Our X-ray diffraction studies show that ignition will transform the purified osseous α phosphate into tricalcium phosphate, while it has no action upon apatite. The raw bone salts are transformed into carbonato-apatite after ignition at 900° C. by combination of the tricalcium phosphate with carbonate ; in fact, this operation does not essentially modify the X-ray pattern obtained from bone salts. The main constituent of the non-ignited complex is thus 'isomorphous' with the ignited compound in spite of the alteration of the chemical properties. After ignition, however, the lines of the pattern are sharper than before because the individual crystals of carbonato-apatite are bigger than those of α tricalcium phosphate[1].

(*c*) The refractive index of bone salts is equal to that of a mixture of 90 per cent pure α tricalcium phosphate precipitate with 10 per cent calcium carbonate, namely, 1·590 ; after ignition, on account of the chemical change produced, the value of the refractive index becomes equal to that of natural apatites, namely, 1·649[3].

(2) Similar observations were made with complexes of tricalcium phosphate and lime such as are obtained after partial hydrolysis of precipitated tricalcium phosphate. Indeed, it is well known that precipitated tricalcium phosphate often contains more calcium than required by its theoretical composition ; in fact, its Ca/P ratio, theoretically equal to 1·94, often reaches 2·15 (characteristic value of apatite) and may even be greater. A partially hydrolysed tricalcium phosphate with a Ca/P ratio of 2·15 resulting from production of lime and adsorption during hydrolysis is not an apatite, though it shows an X-ray diffraction pattern similar to that of apatite ; its main constituent is, as in bone salts, a compound 'isomorphous' with apatite, namely, α tricalcium phosphate. The merely physical complex of tertiary and lime becomes an apatite when ignited at 900° C. This can be demonstrated in the same way as we did for bone[3,4]. We cannot admit, therefore, that the tertiary, with a Ca/P ratio of 1·94, is hydroxylapatite with adsorbed PO_4 ions[6]. That its powder diffraction pattern is the same as that of apatites is not a conclusive argument, because the tricalcium phosphate itself is 'isomorphous' with those compounds.

(3) Finally, we have shown, using up to now optical methods only, that the mineral fraction of ivory and cement from tooth is the same as that of bone. Enamel, however, has a more complex composition, its prisms being formed of real carbonato-apatite, while its interprismatic substance is organic matter impregnated mostly with α tricalcium phosphate[7].

[1] MacIntire, W. H., Palmer, G., and Marshall, H. L., *Ind. and Eng. Chem.*, **37**, 164 (1945).
[2] Dallemagne, M. J., *Acta Biol. Belg.*, **2**, 298 (1942).
[3] Dallemagne, M. J., thèse d'agrégation de l'enseignement supérieur, Gordinne (Liège, 1943).
[4] Dallemagne, M. J., and Brasseur, H., *Bull. Soc. Sci. Liège*, **11**, 451, 488 (1942).
[5] Dallemagne, M. J., and Melon, J., *C.R. Soc. Biol.*, **138**, 1028 (1945).
[6] Bale, W. F., Bonner, J. F., Hodge, H. C., Adler, H., Wreath, A. R., and Bell, R., *Ind. and Eng. Chem.* (Anal. Ed.), **17**, 491 (1945).
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BRITISH EMPIRE CANCER CAMPAIGN

REPORT FOR 1945

AS the twenty-second annual report of the British Empire Cancer Campaign* is the first to be published since the end of the War, it is appropriate that reference should be made to the steady progress in cancer research which has been maintained during the war years. In particular, the first practical chemotherapeutical advance—the treatment of cancer of the prostate with œstrogens—has been made. War research has developed new methods, tools and substances, and some of these should be of help in cancer research in peace-time. The present report summarizes the recent progress.

Interesting results are being obtained in experiments on animals with 2-acetylaminofluorene. Workers in Leeds and Sheffield using this compound have induced tumours of many organs, including bladder, pancreas, liver, lung, breast and ductus acusticus. By dosing mice with 2-acetylaminofluorene a number of bladder tumours have been obtained, and some of these resemble papillomata of the human bladder. In these experiments the carcinogenic agent

* British Empire Cancer Campaign. Twenty-second Annual Report, 1945. Edited by J. P. Lockhart-Mummery. Pp. 102. (London : British Empire Cancer Campaign, 1945.)

was injected into the stomachs of the mice and was presumably absorbed and may have produced its effect after it was secreted in the urine. This fluorene derivative appears to be suitable for studies of anti-carcinogenic or neutralizing agents; but its carcinogenic action is less easily modified by dietetic changes than is the action of the azo compounds such as dimethylaminoazobenzene.

One of the simplest carcinogenic agents is urethane or ethylcarbamate. American workers first found that this compound induced tumours of the lung in mice, and the same result has now been obtained in Britain. When one considers that urethane was used as an anæsthetic and that acetylaminofluorene was introduced as an insecticide, it might seem desirable that all new chemotherapeutic agents should be tested for carcinogenic action before they are widely used in medicine.

Experiments on the antagonism to the carcinogenic action of benzpyrene carried out by Dr. F. Dickens and Dr. H. Weil Malherbe at Newcastle have revealed something of the nature of the anticarcinogenic material present in mouse fat. The action of the fat appears to be due to unsaturated fatty acid derivatives. The most active anticarcinogenic material was present in the phosphatide fraction, and phosphatides inhibit both carcinogenic action and benzpyrene excretion. Cholesterol increases the rate of excretion of benzpyrene and accelerates the production of tumours. The results suggest that metabolism of the hydrocarbon is necessary for carcinogenesis, and that the true or ultimate carcinogen may be a metabolite. The same investigators have studied the remarkable solvent action of aqueous solutions of purines on polycyclic hydrocarbons. The solvent power of purines increases with the number of carbonyl groups and with the number of N-methyl groups in the purine molecule; hypoxanthine with no methyl or carbonyl groups has very little solvent action, but tetramethyl uric acid is a very good solvent for 3 : 4-benzpyrene. Nucleosides and nucleotides have some solvent action but less than that of the corresponding unsubstituted aminopurines.

Work at the Mount Vernon Hospital has thrown light on the relationship of mitosis and carcinogenic action. Thus croton oil, which has a cocarcinogenic effect, induces hyperplasia of the skin, and cantharidin inhibits both mitosis of epidermal cells and the carcinogenic action of benzpyrene. The same workers have shown by fluorescence spectrography that benzpyrene applied to the skin of mice is absorbed in about four hours and disappears within twenty-four hours following a single painting. The specific carcinogenic action of benzpyrene therefore probably occurs within a few hours of application to the skin. Mice were painted with benzpyrene on one flank at midday and on the other flank at midnight. The midnight paintings induced more tumours than did the midday applications. With midnight applications the benzpyrene content of the tissue would be highest during the day when mitosis is most frequent. The evidence obtained indicates that the process of carcinogenesis by benzpyrene occurs while cells are dividing. This is in agreement with the fact that hyperplasia and carcinogenesis are often interdependent.

The results obtained in Newcastle and at the Mount Vernon Hospital taken together suggest that the actual carcinogenic process may involve the action of a metabolic product of a carcinogen on one cell constituent during the process of mitosis.

By investigating statistics of mortality from cancer, Prof. and Mrs. E. L. Kennaway have been able to show that though the incidence of cancer of the scrotum is very much higher among chimney-sweeps than among the general population, the mean age of death from this cause is about the same in the two classes. This is an example of an external factor which increases the incidence of cancer among the population yet has no effect upon the incubation period. A similar effect is shown in the incidence of lung cancer in chromate workers in Germany. There appears to be some mechanism resisting any acceleration in the development of cancer. The fact that types of cancer which tend to be inherited show differences in age of incidence in susceptible families and in the general population suggests that the resistance has a genetical basis.

In addition to work on carcinogenesis, experiments have been carried out on the chemotherapy of cancer, on the relation of viruses to cancer and carcinogens and on the immunity to subsequent tumours which develops when animals bearing tumours are suitably irradiated with X-rays. The report includes accounts of treatment of cancer in several hospitals by irradiation and surgery. The Clinical Cancer Research Committee presents a detailed analysis of the data from more than five hundred cases of cancer of the pharynx and larynx. E. BOYLAND.

INTERNATIONAL ASTRONOMICAL UNION

IN order to set the wheels of international co-operation in astronomy turning smoothly again after the gap necessarily caused in many cases by the war years, the Executive Committee of the International Astronomical Union recently called together as an advisory body representatives from the United States of America and from a number of European countries. At a meeting which took place during March 7–13, in the rooms of the Danish Academy of Sciences, Copenhagen, the following countries were represented: Belgium, Czechoslovakia, Denmark, France, Great Britain, Netherlands, Norway, Poland, Sweden, Switzerland, U.S.A., U.S.S.R. and the Vatican City State. The British representatives were the Astronomer Royal, Prof. W. M. H. Greaves and Prof. F. J. M. Stratton. After a welcome from Prof. Elis Strömgren on behalf of the Danish National Committee of Astronomy and from Prof. Niels Bohr on behalf of the Danish Academy, the meeting settled down to business under the presidency of Sir Harold Spencer Jones, with the guidance of the general secretary, Prof. J. H. Oort, director of the Leyden Observatory.

Committees were appointed to advise the Executive Committee on Publications on Solar Phenomena, on Variable Stars (names, catalogues and ephemerides), on Bibliography, on Fundamental Astronomy and Minor Planets and on Exchanges between Astronomers of different Countries. Annual grants were recommended in connexion with the above and for certain institutions for which the Union has been partly responsible in past years. Among other projects which were discussed favourably, mention may be made of an International Observatory, for which it was realized that the backing of the United Nations Educational, Scientific and Cultural Organ-

isation might have to be secured. The various standing commissions of the Union appointed in 1938 were revised to meet the changes of the past eight years.

Public lectures were given by Prof. H. Shapley on the galaxies and by Sir Harold Spencer Jones on Halley and his times. A colloquium on interstellar material was held in which the following took part: B. Strömgren, ter Haar, Struve, Oort, Minnaert, Stebbins, Lindblad, Shapley and (by proxy) Swings. The meeting was thoroughly successful in gaining its main objectives. It was found impossible to fix the date and place of the next general assembly of the Union, but there were indications that it could not take place before 1948. F. J. M. S.

ANTIBACTERIAL SUBSTANCES PRODUCED BY BACTERIA AND FUNGI

OUR knowledge of the effects of antibacterial substances produced by or derived from bacteria or fungi continues to increase. A new antibacterial substance named 'bacitracin' has been described by B. A. Johnson, H. Anker and F. L. Meleney (*Science*, 102, 376, 1945; and see the *Lancet*, 641, Nov. 17, 1945). It is produced by a Gram-positive aerobic sporing rod, and the crude brew obtained inhibited a hæmolytic streptococcus when it was diluted 1 : 2,000 to 1 : 10,000. Some of the most susceptible organisms were β-hæmolytic streptococcus, pneumococcus, some clostridia, anaerobic staphylococci and some strains of anaerobic streptococci. Gram-negative organisms were not sensitive to it. 'Bacitracin' is soluble in water and butanol, unstable to alkali, stable to acid and to heating to 100° C. for fifteen minutes. Impure extracts were not toxic to animals and did not irritate the conjunctiva. A single intraperitoneal injection of it ensured the survival of 80 per cent of mice infected *via* the peritoneal cavity with a streptococcus, but 30–40 per cent also survived after a single subcutaneous injection and 80–90 per cent after subcutaneous injections repeated every three hours. Subcutaneous injections repeated every three hours ensured the survival of 80 per cent of guinea pigs infected with the gas-gangrene organisms, *Clostridium welchii* and *C. septicum*. It is claimed that local treatment of human infections caused by susceptible organisms are comparable to those of penicillin.

The properties of mycophenolic acid, which is one of the metabolic products of *Penicillium brevi-compactum*, have been described by Sir Howard Florey and his collaborators at Oxford (*Lancet*, 46, Jan. 12, 1946). Mycophenolic acid is said to be the first antibiotic produced by a mould which has been crystallized. This was done by Gosio in 1896, who obtained it from media on which *Penicillium glaucum* was growing. Mycophenolic acid seldom reaches titres of the order of 1 in 100,000 or more and is more active against Gram-positive than against Gram-negative organisms, but its activity is more markedly affected than is that of other antibacterial substances by the size of the inoculum used. It inhibited *Staphylococcus aureus*, *Streptococcus pyogenes* and *C. diphtheriæ*, but did not inhibit *Bact. coli* or *Salmonella typhi*. It inhibits *in vitro* the growth of many strains of fungi pathogenic to man and plants at titres up to 1 in 80,000, but apparently even strong solutions of it cannot kill these under experimental conditions.

In the same issue of the *Lancet* (p. 44) Dr. A. G. Sanders, another Oxford worker, discusses the effects of the antibiotics mycophenolic acid, aspergillic acid, proactinomycin, cheiroline, claviformin, gliotoxin, helvolic acid, penicillic acid and penicillin upon fungi pathogenic to man, and concludes that claviformin and gliotoxin have a powerful action upon them. Gliotoxin is, however, unstable under certain conditions. Further investigation of aspergillic acid and cheiroline might, Dr. Sanders concludes, produce useful results. G. LAPAGE.

VISCOSITY OF LIQUIDS AND COLLOIDAL SOLUTIONS

THE third volume of the proceedings in Russian of the conference arranged by the U.S.S.R. Academy of Sciences on the viscosity of liquids and colloidal solutions, held in Moscow in 1941, has now reached Great Britain (Moscow and Leningrad: Academy of Sciences)*. The volume is sub-titled "Supplementary Reports and Articles from the Section on 'The Viscosity of Molten Materials at High Temperatures'". There are ten original papers and a general discussion on some of these, and on the contributions from the same section published in the earlier volumes.

Of these papers, two are concerned with metals: Polyak and Serge'ev describe an oscillating ball viscometer for aluminium and its alloys, for which metals they also use a capillary viscometer; and Shvidkovskiĭ, Akhmetzyanov, Belyankin and Shushpanov give viscosity-temperature (η/t) curves obtained with a rotation viscometer for steel.

Markovskiĭ discusses the effects of small quantities of MgO, Al_2O_3, SiO_2, etc., on η/t curves for molten calcium carbide, and the remaining seven papers deal with slags and glasses, mostly relating chemical composition to η/t curves. Sokol'skiĭ uses the log log η/t plot, Okhotin gives an empirical formula relating equiviscous temperature to the composition of glasses, and Leĭba and Komar' extend their work on slags, published in Volume 1. There is also a further contribution by Leont'eva, who gets good linear relations between crystallization speeds and fluidity of glasses.

Perhaps the most interesting paper is that of Yevstrop'ev, who discusses the viscosity-temperature coefficient of glasses and other molten systems, comparing the usual well-known equations relating η to temperature. With some glasses and certain salts (for example, sodium chloride and silver nitrate), a plot of log η against the reciprocal of the square of the temperature (as proposed by the author in an earlier paper) gives a better straight line than a plot against the reciprocal of temperature itself; but in other cases neither plot appears to be very satisfactory.

It is most unfortunate that, as an inevitable result of the War, the publication of these reports has had to be so long delayed. Perhaps one may dare to hope that the findings of the conference, brought up to date in some suitable form, may before long be made available in English. G. W. SCOTT BLAIR.

* The first and second volumes were reviewed in *Nature*, 156, 147 (1945).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 8

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the PHYSICAL SOCIETY, at the Royal Institution, Albemarle Street, London, W.1), at 2.15 p.m.—Conference on "Meteorological Factors in Radio Wave Propagation".

Tuesday, April 9

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. D. Winston Aldred: "The New Building Science" (Bossom Gift Lecture).*

INSTITUTE OF PETROLEUM (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—General Discussion on "Transformer Oil".

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "The Atomic Structure of Minerals".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. H. Fremlin: "Velocity Modulation Tubes".

Wednesday, April 10

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. G. Pearce: "Cast Iron in Contemporary Building and Engineering".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Doris L. Reynolds: "The Geochemical Changes leading to Granitization".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. S. Pickles and Mr. W. H. Wills: "Rural Electrification; the Use of the Single Phase System of Supply".

Thursday, April 11

INSTITUTE of FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. H. Fröhlich: "Theoretical Physics in Industry", 3: "Theory of Dielectric Constant and Energy Loss".

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. M. J. Marchbanks: "Coreless Induction Furnaces".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Miss D. Smith: "Electric Motors—Design for the Job".

Friday, April 12

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Problems Associated with the Growing and Treatment of Flax. Mr. G. O. Searle: "Research and the Flax Industry"; Prof. A. E. Muskett and Dr. J. Colhoun: "The Diseases of Flax, with Special References to Seed-borne Diseases and their Control"; at 2.30 p.m. (joint meeting with the MICROBIOLOGICAL PANEL OF THE FOOD GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY)—Mr. T. W. Brandon and Dr. C. B. Taylor: "Recent Developments in the Retting of Flax and the Dispersal of Waste Waters"; Dr. L. A. Allen: "Recent Developments in the Microbiology of Retting".

INSTITUTION OF CHEMICAL ENGINEERS (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11 a.m.—Twenty-fourth Annual Corporate Meeting: at 12 noon—Mr. Hugh Griffiths: "Vapour Phase Adsorption" (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. E. A. Milne, F.R.S.: "The Spiral Character of External Galaxies".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Mr. C. S. Wright: "Science and the U-Boats—The Technical Battle of the Atlantic 1939–1945".

INSTITUTE OF FUEL, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 5.45 p.m.—Mr. J. A. Kilby and Mr. W. G. Cameron: "Waste-Heat Boilers in the Iron and Steel Industry" (Industrial 'Waste Heat' Recovery Series, 9).

Wednesday, April 10—Friday, April 12

INSTITUTION OF NAVAL ARCHITECTS (at the Institute of Marine Engineers, 85–88 The Minories, London, E.C.3), at 10.15 a.m. each day—Annual General Meetings.

Thursday, April 11—Tuesday, April 16

BRITISH PSYCHOLOGICAL SOCIETY (at University College and Hatfield College, Durham).—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ELECTRICAL ENGINEERING in the Leeds College of Technology—The Director of Education, Education Department, Leeds 1 (April 13).

LECTURERS (2, Honours Graduates) to teach in Achimota College, Gold Coast, to the standard of B.Sc. (London External) in one of the following groups: (*a*) Theory of Structures, Structural Design, Surveying, (*b*) Thermodynamics, Applied Electricity, or Applied Electricity, Electrical Power, Principles and Design of Electrical Machines—The Secretary (IER/CA), Ministry of Education, Belgrave Square, London, S.W.1, or to the Secretary, Scottish Education Department, 10 Abercromby Place, Edinburgh 3 (April 15).

DIRECTOR OF AERONAUTICAL INSPECTION in the Civil Aviation Directorate, Government of India—The High Commissioner for India, India House, Aldwych, London, W.C.2 (April 16).

PROFESSOR OF PATHOLOGY, Punjab Veterinary College, Lahore—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (April 16).

RESEARCH ASSISTANTS (senior and junior) to conduct applied research on pilot and full-scale plants in Chemical Engineering—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.138.XA (April 16).

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (April 18).

PROBATIONARY ASSISTANT IN AGRICULTURE, an ASSISTANT LECTURER IN AGRICULTURAL ZOOLOGY, and an ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary and Registrar, University College of North Wales, Bangor (April 20).

MICROBIOLOGIST in the Cider Section at Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (April 20).

CHAIR OF CHEMISTRY—The Principal, Heriot-Watt College, Edinburgh (April 22).

WATERWORKS ENGINEER for the Cawnpore Development Board—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (April 23).

LECTURER IN MINING, and a SENIOR LECTURER IN ELECTRICAL ENGINEERING—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (April 25).

ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary, London School of Economics, Houghton Street, London, W.C.2 (April 25).

CHIEF FUEL ENGINEER to the Ministry of Fuel and Power—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting C.58.A (April 27).

HEATING AND VENTILATING ENGINEER in the Air Ministry in London—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting C.41.A (April 29).

SENIOR LECTURER IN ZOOLOGY in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (April 30).

LECTURER IN CIVIL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING—The Registrar, University College, Southampton (April 30).

ASSISTANT LECTURER (man or woman), and a DEMONSTRATOR (man or woman) IN THE CHEMISTRY DEPARTMENT of the Medical School—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1 (April 30).

LECTURER (Grade II) and an ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Southampton (April 30).

LECTURER OR ASSISTANT LECTURER IN ASTRONOMY, a LECTURER and an ASSISTANT LECTURER IN NATURAL PHILOSOPHY (PHYSICS), a LECTURER OR ASSISTANT LECTURER IN ZOOLOGY, an ASSISTANT LECTURER IN CIVIL ENGINEERING, and a LECTURER and an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Secretary of University Court, The University, Glasgow (April 30).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (April 30).

LECTURER IN EDUCATION with special qualifications in EDUCATIONAL PSYCHOLOGY—The Registrar, University College of Wales, Aberystwyth (April 30).

STATE CHEMIST in the State Laboratory—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (April 30).

LECTURER IN PSYCHOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (May 4).

UNIVERSITY LECTURER IN ENGINEERING (AERONAUTICS)—The Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (May 13).

CHIEF RESEARCH OFFICER, H.M. Forestry Commission—The Secretary, H.M. Forestry Commission, 25 Savile Row, London, W.1 (May 31).

LECTURER IN MINING—The Principal, Huddersfield Technical College, Huddersfield.

LECTURER IN MECHANICAL ENGINEERING in the Crumlin Mining and Technical College—The Director of Education, County Hall, Newport, Mon.

LECTURER IN PHYSICS, an ASSISTANT LECTURER IN CHEMISTRY, and a LECTURER OR ASSISTANT LECTURER IN ECONOMICS—The Registrar, University College, Exeter.

READER IN PHYSIOLOGY AND HEAD OF THE DEPARTMENT, a LECTURER IN INDUSTRIAL ELECTRONICS IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING, an ASSISTANT LECTURER IN MATHEMATICS, an ASSISTANT LECTURER IN PHYSICS, an ASSISTANT LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN PHYSICAL GEOGRAPHY—The Registrar, University College, Nottingham.

TECHNICIANS (2) IN THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY, and a MECHANIC to build up and operate a Laboratory workshop—The School Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

LABORATORY ASSISTANT (man or woman), Grade II, IN THE DEPARTMENT OF PHYSICS—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

SOIL TECHNOLOGIST by the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14628.